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ABSTRACT

This book focuses on 10 of the most promising new technologies and the careers that they will foster, picking up where the 1983 book, "Emerging Careers" by Norman Feingold, left off. The book talks about the work that must be done in new ways as technological breakthroughs open new applications. By looking first at the technologies and their current and anticipated applications, the book anticipates opportunities in the workplace. Each chapter provides an overview of an emerging technology, discusses employment opportunities created by it, and outlines career opportunities, with descriptions of specific jobs and details on education and training. Each chapter concludes with a selected bibliography of suggested reading and references, and names and addresses of organizations offering additional information or literature. The 10 careers profiled are the following: biotechnology careers; laser careers; robotic careers; information technology careers; telecommunications careers; information management careers; computer careers; aerospace careers; medical technology careers; and superconductivity technology careers. The final chapter addresses career decision making through self-knowledge, research and planning, and professional guidance. Seven appendixes provide information on work and careers in the future, emerging career fields, futuristic exercises, a high technology futuristic quiz, and an index of emerging career fields cited in the book. (KC)

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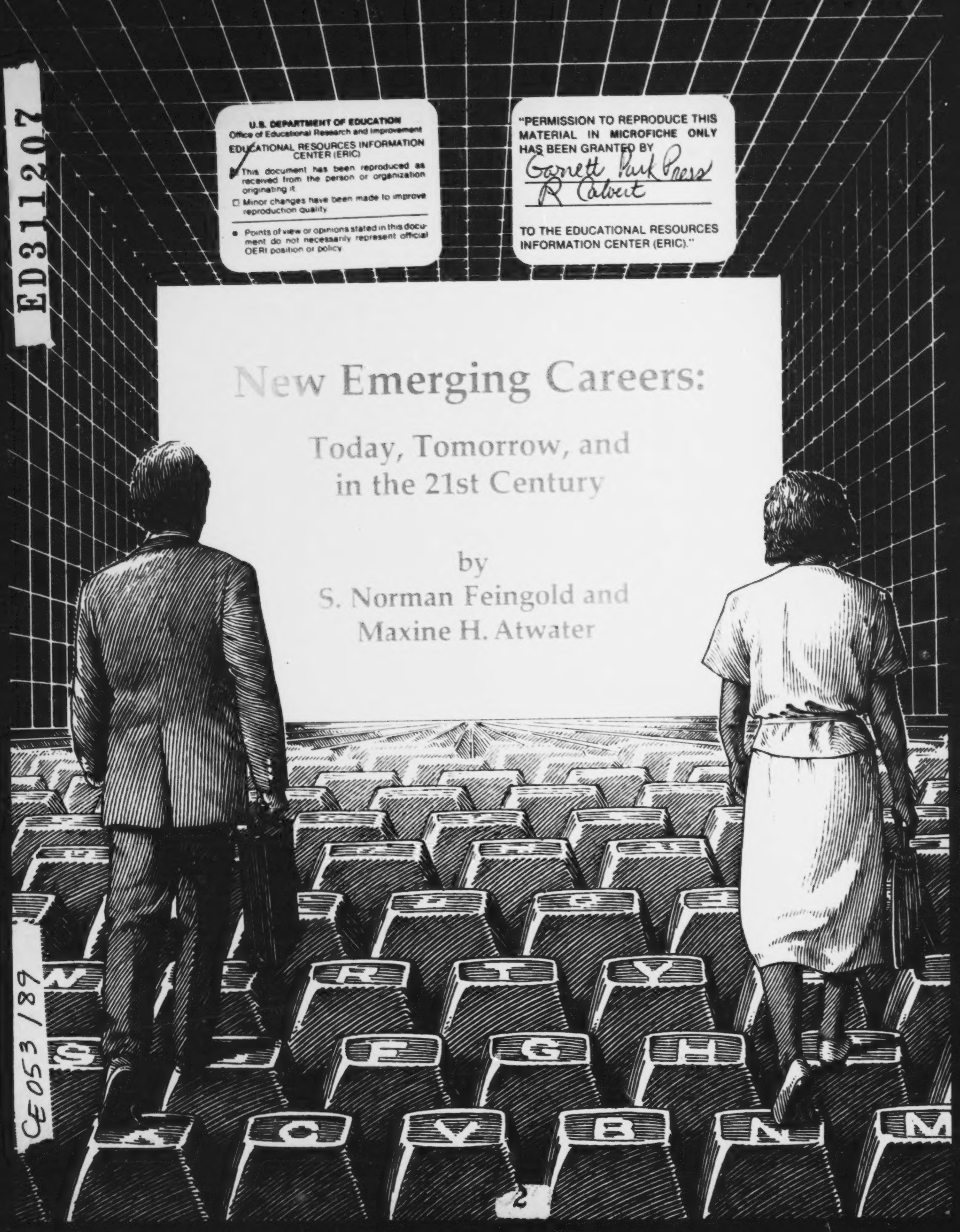

New Emerging Careers:

Today, Tomorrow, and in the 21st Century

by
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Maxine H. Atwater

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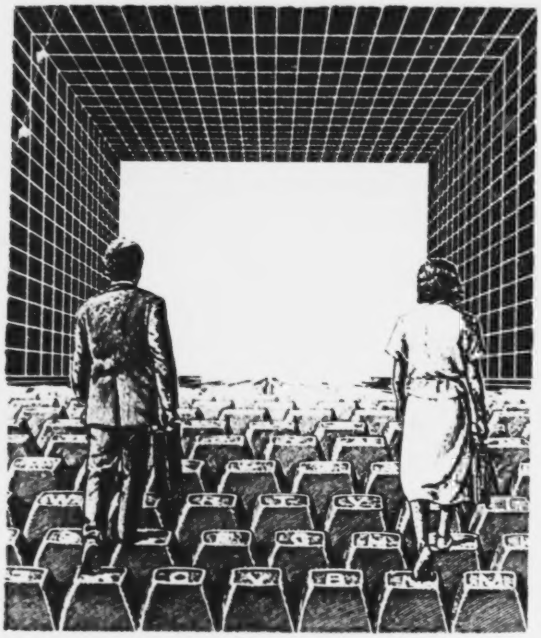
Introduction
TOMORROW'S ANOTHER DAY

"Change is the law of life. And those who look only to the past or the present are certain to miss the future."

—John F. Kennedy, 1963

Although change has always run alongside life itself, not until now has it galloped ahead. Like a stallion unleashed on an open plain, change today speeds across the landscape of our era.

"Who—or what—let 'im loose?" we ask as we saddle up in pursuit of our metaphor. "And just why is change running at such a clip?"



Most agree it's the introduction of a roster of revolutionary technologies that's causing things to change so quickly and profoundly. The coming of the Age of High Technology has an impact on our present and future that's difficult to fully comprehend.

And of all these high technologies none creates more changes in our lives than our ability to imprint electronic components and circuits on tiny chips. With the emergence of microelectronics, we're transforming our world. Now, in place of the clang of huge machines with hundreds of moving parts, mechanisms one-fourth the size of a postage stamp do the job without no more than an occasional bleep. By miniaturizing our source of electric power, we not only save space and cut expense, but also gain control and flexibility.

Like a pebble dropped in a pond, the microelectronic revolution sets off a chain reaction eventually felt throughout society.

"No technology in history has had such a broad range of potential applications in the workplace," believes science author Colin Norman.

Microelectronics opens the way for hundreds of new applications. Foremost among these are, of course, the computer and microprocessor. These devices have changed not only the kinds of things we produce, but also how we produce them. Ultimately, computers are making all other high technologies possible. With each new technology a world of new applications opens. And as new products and services become possible, new people with new skills must often be found to create them.

Technologies blossom. Applications flower. New jobs proliferate.

All unleash change.

But if we're to catch up with rampant change, we'd best prepare for the chase and do so quickly.

This new book tells you how by providing you with needed information to make educated choices. These pages focus on ten of the most promising new technologies. Picking up where Norman Feingold's 1983 book *Emerging Careers* left off, we've expanded on the careers pinpointed in that book. We've also added new ones. Specifically, since *Emerging Careers* devoted four chapters to energy industry careers and two to ocean industry careers, we omitted these. But also *Emerging Careers* included chapters on computers, robotics and space, we've also included these because recent developments demanded their expansion. Other technologies not included in *Emerging Careers* have been added: biotechnology, lasers, information management, telecommunication, medical technology and superconductivity.

This is a book about the work that must be done in new ways as technological breakthroughs open a treasure box of potential applications.

By looking first at the technologies, their current and anticipated applications, we begin to see future opportunities in the workplace.

Each chapter provides you with an overview of an emerging high technology, and discusses employment opportunities created by it.

Chapters then outline career opportunities, with descriptions of specific jobs and details on education and training. Each chapter concludes with a selected bibliography of suggested reading and references, and names and addresses of organizations offering additional information or literature.

Our hope is that with the information we provide you'll be able to catch up with and take charge of the change running rampant in our time.

Giddyap and Full Speed Ahead!

Chapter 1

FUTUREWORK: TRIUMPH OF THE MIND

"The empires of the future, are the empires of the mind."
—Winston Churchill

People in the late 1980s, began to realize that the future existed only in their imaginations. Some acted upon their visions to create the reality we will enjoy in the 21st Century.

The changes you've lived through began decades before in the minds of the men and women. Your own life is a prime example. Looking back you can see the connections between what you dreamt as a young person and where you are today. For it was in your student years in the late 20th Century that you began creating the career success you will enjoy in the 21st.

How did you manage changing the dream into a reality? First, you exposed yourself to the visions of others and cultivated your own. Then you focused on a couple of the future dreams that thrilled you most. Fortunately, you knew that when people are sufficiently motivated, it's only a short leap between imagining and creating.

Next, you filled in the gap by doing what was needed to make your vision a reality. You went into action studying, experimenting, adapting, inventing. You worked in one area and moved to the next, and, of course, as you progressed, you continued to imagine tomorrow, and the future beyond that.

Imagining, Understanding, Planning.

These three keys unlock a future filled with satisfying and meaningful work. We begin with our vision of how life can be, seek to understand what forces shape tomorrow's scenarios, and plan and take the steps necessary to make it real.

Understanding develops as you track the trends, study forecasts and note the cutting edge developments of the day. By doing so you get the information you need to plan your future. Reading this book is one step in that direction. Another is zeroing in on the basic message in this and other books: More than ever before success in the future will depend on your knowledge of science and technology.

"Study science" educators, employers and counselors advise. Among them is Dr. Curtis Graves, deputy director for NASA's Civil Affairs, who believes that students who enter science, math and engineering today "will reap a big harvest by the turn of the century." This is certainly true at NASA where Dr. Graves says 65 to 70 percent of the workforce is made up of technical people.

Doing something about the dearth of scientists that Dr. Graves foresees are the people at the American Association for the Advancement of Science. Under their sponsorship of Project 2061 (named for the year that Comet Halley next returns) a panel of distinguished scientists and educators are identifying what basic science, mathematics and technology students must know to be high-tech literate.

"We're trying to see that people learn their scientific 3Rs for the 21st Century," explains Project director Dr. James Rutherford. Rather than learning the principles of evolution or the mechanics of mathematics computation, the Project committee recommends that people focus on the world view of science, its philosophy and nature.

Dr. Rutherford and his committee believe that people must understand how science and technology fit together. "They overlap. Scientific knowledge fuels technology. On the other hand you can't get anywhere in science without technological devices like telescopes, x-rays, and thermometers.

"Since we live in a changing world and don't know what will be demanded of us, we must have a knowledge base," Dr. Rutherford thinks. "Once we have an intellectual foundation to build on, we'll be able to learn the new things to adjust to changes we can't foresee."

Toward this end, he advises that while in school everyone should get a solid education in science, math and some technology "because they're a good bet." Dr. Rutherford suggests taking science even before you know what career you want. "Then if you decide to be a scientist you won't have to begin your education all over again." He sums up his case for a science education: "If you get a strong science education and don't use it in your career, then you at least understand the world. And if you do decide to work in any aspect of the field, then you're in a position to move."

Broad Learning

The biggest opportunities in the future—as now—may be for those who combine disparate disciplines. One example from a *U.S. News & World Report* article, "Jobs of the Future" (Dec. 23, 1985) is the U.S. product manager for a German computerized X-ray scanner who combined an undergraduate major in computer programming with a master's degree in physiology.

"Don't get wedded to an exclusive technology," agrees Dr. William Troxler, president of Washington, D.C.'s Capitol College.

"As rapidly as technologies are born, they die. So you need a broad background, specifically 'Letters and Science' education," he says. "That way you'll be able to adapt to changes—the new gadgets—that evolving technology necessitate."

Capitol College is developing a curriculum that ties liberal arts and technology together. It has three components: classic liberal arts, business including how to make a business plan or get a bank loan, and science with an introduction to the basic technologies of today.

Life-Long Learning

Just as broader education is seen as essential for future success, so also is continuing education. This is because tomorrow's labor force needs life-long education, both to keep up with jobs and to prepare for career changes. Because of these educational needs, workers of tomorrow are likely to push for continuous retraining and education benefits. To attract employees who can adapt to new processes and skill requirements, companies are beginning to initiate new educational policies.

Authors John Naisbitt and Patricia Aburdene writing in "Reinventing The Corporation" see the evolution of a new alliance between business and education. Corporations are beginning to take on the responsibility of educating their employees not just for the job at hand but for their lifetime.

Noting the tendency for businesses to become more involved in education, Executive Director Curtis Plott of the American Society for Training and Development predicts that the money companies spend in training employees will triple in the next decade.

Mindpower

Up until now the foundation of our economy has relied on a strong back. Soon it will rely more fully on a strong brain.

In the 21st Century we'll need an enhanced willingness and ability to think. At last the mind will triumph because the industrial age has ended and the information age has begun. Instead of man adapting himself to the machine, now for the first time the machine will adapt to man.

Although it may seem that we conquered the machine long ago, in fact we've been machinery's slave. Until now we've been forced to accommodate ourselves to the limited capabilities of machines. But now with computers being developed that respond to our oral commands, we'll shift roles from the slave of the machine to its master.

"Machines will become human literate," sums up technology consultant Jack Powers of Interactive Features.

With computers as servant, we'll be freed from routine tasks and other work that requires minimal thinking. What will we do instead?

Think harder, deeper and longer.

With information and service as the basis as our economy we'll by necessity have to spend more of our time analyzing and repackaging the data and facts. As Samuel E. Bleecker points out in *The Futurist* (July 1987), we'll move from collecting data to connecting and arranging facts in a particular way for a specific purpose.

He believes that as employees many of us will increase our new responsibility—stepping outside our "job descriptions"-to do more of what's needed to make our organizations successful. Bleecker explains that as the information age heats up and response time becomes critical, in order to complete companies will have to shift authority from top management to a broader group of employees.

Thinking will require new levels of involvement. As the organizations for which we work become less hierarchical and distribute more responsibility among employees, the way will open for us to think from management's viewpoint. We'll identify with company goals, understand more, and create in new ways.

In the information management industry some people are already leaping the fence into a creative thinking domain. Where managers of information systems were once involved exclusively with the technology of collecting and accessing data, now their role is expanding. The new breed of information officer is showing management how information resources can be used in strategic planning. Where once as technicians they concentrated on processing information, as creative thinkers they now focus on designing technical solutions to achieve the goals of business. (See Chapter 7.)

The elevation of our role in the workplace will gradually change our attitudes and feelings about work. Few of us in the future will be working simply for a pay check. To the contrary, more will note a rising enthusiasm for work, a feeling that some might even venture to label "love."

In addition to the changes in management that will enable us to play on the team at work, there's another reason why we'll tend to love our work more in the future: we'll be more able to choose what we love to do in the first place.

We'll become more aware of the spectrum of possibilities open to us. And once we decide on the work we'd like to do, we'll know better how to prepare. More importantly, we'll not let the limitations of the past stop us. Rather we'll imagine our future. Then we'll study to understand, we'll plan and we'll do the research for our destination.

"The future is not what it used to be," author Joseph J. Corn writes in his book *Imagining Tomorrow*. No, our vision of what's possible changes everything. By imagining, understanding and planning we'll shape our future work and make tomorrow what we want it to be.

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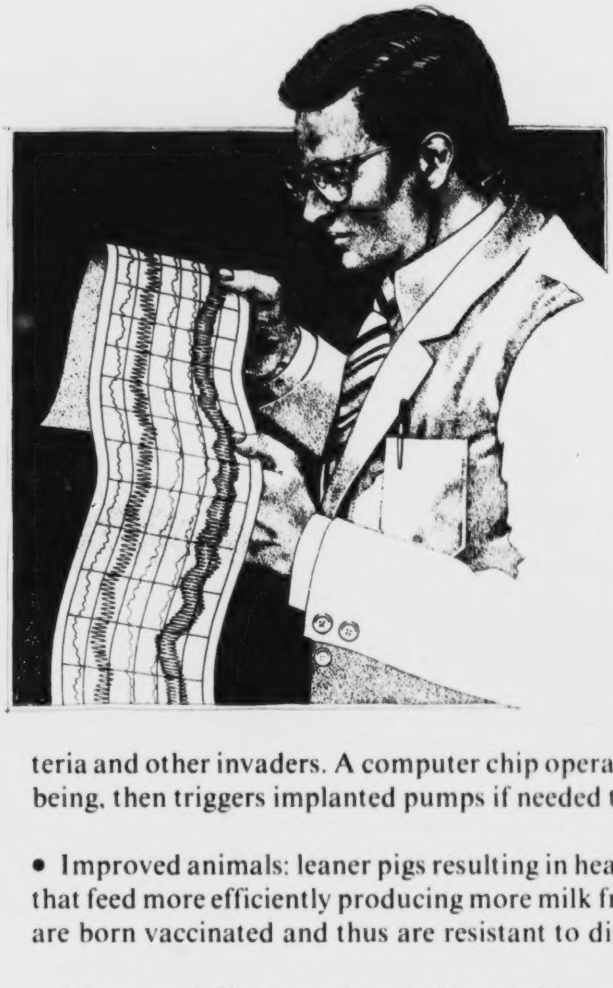
Chapter 2

BIOTECHNOLOGY CAREERS

"The future enters into us in order to transform itself in us long before it happens."

—Rainer Maria Rilke, 1904

As a child did you pretend that you were a magician and pull a rabbit from a hat? If so, you previewed what could be your work as an adult. Biotechnicians are modern-day magicians who manipulate life—and they don't even use hats.



With test tubes and petri dishes this new breed of scientists are altering organisms at the molecular and cellular level. In doing so they turn microorganisms into factories that produce all sorts of products never before possible or even imagined—everything from fuel to medicine, from food to vaccines, from chemicals to plastics.

Over 150 such products have already been approved by the FDA and hundreds more are at various stages of clinical trials.

Rivaling the best magic tricks are the wonders on the horizon.

- Enhanced health: A one-time vaccine against malaria, sleeping sickness, and parasitic worms. Antibodies that harness the body's own immune system to better defend us against viruses, bacteria and other invaders. A computer chip operating inside the body that monitors our well being, then triggers implanted pumps if needed to release insulin or switch on pacemakers.

- Improved animals: leaner pigs resulting in healthier pork for human consumption. Cows that feed more efficiently producing more milk from the same amount of feed. Animals that are born vaccinated and thus are resistant to disease.

- Insect- and disease-resistant plants, with some that produce drugs to combat human diseases. "Perhaps we will be harvesting human insulin from the 'North 40' instead of from huge fermentation tanks of genetically engineered E. Coli," says Monsanto's senior vice president Howard A. Schneiderman.

Biotechnology Defined

What is biotechnology? Broadly speaking it's the application of biological systems or organisms to technical and industrial processes. This definition made up by a White House team in the 1970s "is a wide enough net," writes Tommy Ehrbar in *Pitt Magazine*, "to include fish farming, producing enzymes for laundry detergents, and manipulating bacteria to clean up oil spills or to produce insulin." Although we have been using microorganisms since 6000 BC to ferment alcoholic beverages, contemporary biotechnology springs from the 1953 discovery of DNA. The material that makes up the chromosones in the cells of all forms of life.

The multi-billion-dollar biotech boom has just begun," Erhbar writes. "Its champions predict that cancer and diabetes can be cured, memory boosted, famine ended and life prolonged."

Although often mistakenly thought of as synonymous with biotechnology, genetic engineering is but one of several biotechnological techniques. Two others are monoclonal antibody technology, which uses antibodies for better and cheaper medical tests, and bioprocessing engineering (fermentation).

What unites all these processing techniques is their common use of biological agents—those microbes that are creating in laboratories an increasing proportion of our food, medicine and other products.

The industrial value of the microorganisms has increased significantly since the discovery of recombinant DNA and RNA techniques. These techniques have made possible cell fusion, protein engineering, and other bioprocesses. Now, with utmost control, scientists engineer their production of antibiotics, enzymes, vitamins, and amino acids.

Other recent breakthroughs have prompted experts to predict that biotechnology will soon match the computer as far as its impact on our lives.

Numerous Applications

The numerous applications of biotechnology can best be surveyed if we break them down into those relating to human health, agriculture and the environment.

In Health Care—Already giant strides have been made to enhance our health and well being with the production of new, better and cheaper drugs. Thanks to biotechnology, we are now able to produce human insulin more abundantly and cheaply than ever before possible—a boon to diabetics. Also, the problems that cause some forms of dwarfism are now being remedied with the new biotechnological production of growth hormones.

Researchers at the National Institutes of Health have succeed in genetically altering mice so that their milk produces a human protein that may prevent heart attacks.

In addition, gene splicing technology is allowing the development of chemicals that dissolve blood clots in heart attack victims and of those that clot the blood in hemophiliacs.

Anticipated in the future are cures for cancer and genetic diseases, such as sickle cell anemia. And to prevent disease, biotechnology is identifying the substances that form the body's antibodies; vaccines for a number of diseases are now being tested.

In Agriculture—Through biotechnology, strains of bacteria are being used to produce crops that can live without water for weeks, resist disease, and produce triple yields.

On the horizon are new and improved plant varieties including those that can fertilize themselves and grow in salty soil. Through cellular manipulation scientists are also producing plants that are resistant to insects and pesticides and herbicides with increased specificity. Testing of a genetically altered bacteria that retards frost formation on leaves began in California in 1987.

For animal agriculture, biotechnology is producing food additives, animal feed supplements, and agents that diagnose disease. The technology is at hand for genetically altering animal cells to produce desired characteristics like rapid growth and resistance to disease.

In the Environment—In addition to producing enzymes in the laboratory biotechnicians are genetically altering micro organisms to improve microbial systems for the environmental control of air, water and soil.

Already available are bacteria that eat oil spills. To provide petroleum and natural gas cheaply, bacteria are being altered to produce hydrogen and carbon dioxide from agricultural waste such as leaves, stalks and wood. Micro organisms are also going to work to extract and purify oil and detoxify chemicals.

Industry Forecast

In 1980 the U.S. Supreme Court ruled that new life forms created in laboratories could be patented. The ruling opened the door to the first commercial application of the science of biotechnology. With 3,000 patents approved, more than $2.5 billion in private investment capital flowed into industry to start more than 100 new companies.

From 1980 to 1985 the number of biotechnology-related companies tripled. Today, many experts believe that by the year 2000, biotechnology will be the top growth industry in the world, surpassing autos, steel, computers and electronics. Optimists believe the new science may even spark the reestablishment of the United States as world leader in technology and manufacturing.

Estimates call for the industry to be valued at between $15 to $100 billion by the turn of the century. Why such a wide range in forecast? The answer is that experts vary in how they define biotechnology and in their assumptions about market penetration. Some believe that even the highest estimate does not take into account the repercussions of an exploding industry on suppliers. In 1983 only a few hundred U.S. firms sold $1.4 billion worth of chemicals, other biotechnological materials, instruments and equipment. By 1990 the need for everything from centrifuges to gene machines could gross $3.33 billion—a 236 percent increase in just seven years.

As Monsanto's Schneiderman sums up:

> "In the year 2984 steam power, electric power generation, nuclear power, fusion power, transistors, microprocessors, all will long have become historical novelties. Remaining, however, as an indelible part of the future society at a millennium hence, will be the application and process of biotechnology. We, using nature's own methods, will have learned to persuade her to be a full partner in humanity's major enterprise—civilization."

Job and Career Outlook

"The new tools offered by biotechnology are already offering totally new employment opportunities." John Eklington writes in his book *The Gene Factory*. He believes that biotechnology is "laying the foundation for new industries whose areas of business were unimaginable just a few short years ago."

Specifically, the bioindustrial revolution is beginning to create more need for scientists and engineers who are trained in genetic engineering, fermentation technology, and microbiology. A U.S. Office of Technology Assessment report estimated that in 1984 there were only 5,000 employed in biotechnology research and development, and that half the technical personnel in biotechnology firms were molecular biologist and immunologists manipulating genes. Therefore, from now on, and far into the future, we predict growing demands for these specialists: according to a report by the center for Occupational Research and Development of Waco, Texas U.S. companies will need over 1000 new biotechnicians annually through 1995.

Engineers

As with the computer industry, where at first programming was done by Math PhDs, biotechnological posts now are mainly staffed by biologists and biochemists. That will change, however, as companies move beyond research into production, and engineers will be in demand. Then engineering skills will become critical to developing production systems, including electronic monitoring and methods to produce a high product yield.

Bioprocess Engineers—Like biochemists and microbiologists, bioprocess engineers develop methods for the large scale production of biotechnology products. The Office of Technology Assessment sees a shortage of those who can design and monitor the processes to scale-up production. Experts worry that a shortage of such experts could put a damper on the rapid commercialization of biotechnology.

As many companies get into the production phase of biotechnological products, they'll need to add to their workforce experts who can design sophisticated fermentation vats for microorganisms which produce biotechnology products. Although fermentation vats have been used for centuries to make beer and wine, the micro organisms used in biotechnology are more delicate and difficult to grow than yeasts. Needed are sophisticated systems to control their temperature and the concentrations of various chemicals.

Although eventually the size of the biotechnology industry will demand more specialized expertise, in the near future needs for bioprocess engineers will be drawn from the present supply of chemical engineers.

That's because many of the techniques used in biotechnology are similar to those used in chemical engineering. In the new field chemical engineers will apply their skill in fermentation tank operation, continuous and batch reactors, and the techniques used in petrochemical and food processing, pollution control and energy production.

Mechanical and electrical engineers will be in demand to design and build the equipment used in genetic engineer plants and the systems and instrumentation needed to regulate the equipment.

Scientists

Also needed will be the following types of scientists:

Genetic Engineers—The biggest demand now and in the future will be for these specialists whose expertise combines that of a biologist and a chemist. Much as traditional engineers design machines to perform specific functions, the genetic engineer designs genetic material to produce desired results.

Biochemists—These scientists study the chemical processes of living organisms and to develop production techniques including recovery, purification and quality control.

Immunologists—These specialists manipulate genes, and study human and animal antibodies—particularly in monoclonal antibody technology and drug research.

Enzymologists—These specialists, who produce and use enzymes, will be needed in many areas of research and production.

Industrial Microbiologists—There may be a shortage of these scientists who isolate, screen and select micro-organisms with particular properties and then determine the best environments for them.

Technical Experts

The demand will also grow for a variety of technical experts:

Process Control Personnel—These experts monitor and control production just as chemical and drug plants production is presently controlled.

Instrumentation Specialists—These specialists are experts in electronics or computing and also have an understanding of biochemistry and analytical chemistry.

In addition there will be a growing demand for less obvious areas of expertise:

- computer scientists with background in agriculture, environment, mining and petroleum.
- biotechnical machine operators and craftsmen.

- professional managers,
- marketing and sales personnel,
- lawyers and regulatory specialists,
- financial analysts,
- managers with broad science background and proven skills,
- in-house recruiters and personnel specialists who in addition to the customary skills also design compensation packages, train and counsel.

Jobs will be created as biotechnology products become more widely available. Unlike the computer where specialized skills are needed, biotechnology products will be distributed similar to those they replace. The physician will still prescribe drugs that capitalize on biotechnology; farmers will plant genetically altered crops just as they did more traditional harvests.

Biotech Lawyers

A new variety of patent lawyer will be in demand as the applications of biotechnology create new products in the 21st century. This new breed of patent lawyer will have specialized expertise in biochemistry, genetics or pharmaceutical medicine with most holding advanced degrees. The future looks so bright that one New York law firm is already recruiting scientists from research labs and paying their way through law school.

Getting Ready

Greatest opportunity is for bioprocess engineers and shortages are already forecast. Until now bioprocess engineering has been considered a specialty within chemical engineering. But now bachelor's degree programs in the field are being established by various educational institutions.

For others seeking careers in biotechnology, the first question should be "How can I bridge two or more disciplines." In a field that is non-labor intensive, competition could become fierce for a small number of jobs.

The job candidate with a broad overview of the industry should come out ahead. In most cases that means combining areas of expertise. For example, those developing biosensors will need to master synthetic polymer chemistry and understand the interface of biological molecules with electrical devices. Other combinations that will pay off: engineers and computer scientists with backgrounds in agriculture, environment, mining and petroleum; and sales managers and legal experts who understand biological research.

Schools and Universities

Universities across the country are focusing on biotechnology. Although there are no degrees in biotechnology per se, Cal Tech, MIT and Stanford are at the forefront of molecular biology and genetic engineering.

Twenty seven states have created biotechnology centers to integrate various research programs within the state and to provide basic technical support for industrial development. At the Maryland Biotechnology Institute at the University of Maryland 72 scientists and other employees carry out research in agriculture, medical, marine, and advanced research. In addition, the Institute provides training to graduate students and other scientists. For a directory of state biotechnology centers write the Biotechnology Information Program, North Carolina Biotechnology Center, PO Box 13547, Research Triangle Park, N.C. 27709-3546.

Although master's degrees in microbiology and genetics will be needed to advance in scientific positions, biotechnology also will offer opportunities to those with solid technical skills. Assistant Professor of Biology at Rochester Institute of Technology Jean Douthwright-Fasse thinks companies "will be very pleased to have students with AS degrees."

Echoing this optimistic view is the report by The Center for Occupational Research and Development which concluded that about 200 graduates of two-year biotechnology programs should be able to find employment annually between 1985 and 1995.

In addition to the Rochester Institute of Technology, a number of other schools offer two-year biotechnology programs including Monroe Community College in Rochester and Alfred State College of Alfred, New York.

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Chapter 3

LASER CAREERS

"The future is called 'perhaps' which is the only possible thing to call the future. And the important thing is not to allow that to scare you."
—Tennessee Williams, 1957

Primitive men and women may have implored the power of nature by the light of the moon, but modern men and women need a light source of a different magnitude.

Illuminating our path as we step into the 21st Century will be a man-made light with the power to cut through steel and to create heat greater than that on the surface of the sun. Its beam already gleams in factories, offices, hospitals and laboratories across the country—the light that lit our earliest fantasies of an all-powerful embodiment of the sun itself—the *laser*.

As for the career opportunities in laser optics, most fields simply can't hold a candle to its bright outlook. That's because applications are multiplying as the cost of manufacturing equipment to produce laser light decreases.

Lasers have come a long way since the first beam pulsed in 1960. What was once thought to be a solution in search of a problem, is now considered the dynamo of the 21st Century.

The present day applications of the laser are impressive; those which experts see as reasonable expectations for the future boggle the mind. If you choose to be part of the laser industry you may be on hand as these wonders come to fruition in the near or more distant future. Pretending it's already the year 2025, here's what the headline story in your morning paper may announce:

> By using light to process information, optical computers process information much faster and are able to store more information—10,000 pages of information on one 4.72 inch wide computer disc.
>
> Harnessing the capability of lasers to give off monochromatic light, scientists now observe living cells in colors and see exactly what is happening chemically. Basic knowledge of this sort is leading to the employment of new drugs to combat disease and aging.
>
> Using a tiny, low-power infrared laser beam biologists can trap a cell's nucleus and move it to a new site within the cell. This ability to maniuplate cells is expected to become an important research tool.

By scanning the ocean surface with a laser by air, oil spills are detected quickly so scientists can deal with them before they reach the shoreline or seriously harm sea life.

With the refinement of the marriage between the computer and the laser, shoppers now use a video scan to visually communicate their measurements and preferences to clothing manufacturers. The computer guides the laser to custom cut the desired garment.

Laser gyroscopes are now used to align space vehicles for docking, landing and flight trajectories. Lasers are also being used to measure the distance, spin, size and speed of spaceships and asteroids over the vacuum of space,

With the launching of greater numbers of laser-fusion powered space ships, space is now open to individual explorers, not just governments and giant corporations. "Laser-pushed Connestoga wagons stream into the final frontier" Allan Maurer.

The billion-dollar research programs initiated in the 1980s to produce an inexpensive fusion power pays off. By the end of the 21st Century, a bank of ultra-powerful lasers produce power to initiate a nuclear reaction. This fusion delivers a trillion watts of power—more than all the power plants in the entire U.S. could generate in the same period of time.

If these future scenarios excite you, the laser industry may be for you so read on.

What are Lasers?

So what exactly are these miracle-making lasers? The word "laser" itself is an acronym for Light Amplification by Stimulated Emission of Radiation.

Invented in 1960 by two young American researchers, the laser is a device that by focusing light waves stimulates atoms to amplify and concentrate the light waves. When emitted the light is continuous, and very intense. Unlike other light sources, lasers are a form of concentrated, coherent light in which the photons are synchronized. Unlike other light sources, the laser's photons begin life in the same phase, which means that their waves line up exactly and they remain aligned because they have the same frequency.

A light beam of such power can do things formerly thought impossible like cutting through two-inch thick steel in a fraction of a second and trigger thermonuclear fusion. Narrowed by optics, the laser can drill 300 separate holes on the head of a pin or drive a nail instantly through a wall.

In addition to its cutting and burning power, other characteristics of the laser are being utilized. The laser is now being used:

to fuse detached retina without use of anesthesia,

to transmit messages over fiber optics the size of human hair,

to align pipes and tunnels,

to measure the distance to stars.

To best understand the laser, think of it as an instrument that uses light instead of a machine to focus energy.

History of the Laser

Although the concept of laser has been around since the turn of the century, creating a working laser wasn't easy to do.

Researchers looked long and hard for the right basic material to tap the laser's power. In 1960s Dr. Theodore Maiman, a researcher at Hughes Aircraft Co., cast a laser beam through a ruby crystal. The beam of red light that he created was, as Isaac Asimov wrote, "a variety of light never before seen by the eyes of man."

From that first faint gleam applications gradually increased. By the mid-'70s scientists had discovered that crystals, solids, liquids and gases could also be used to produce different kinds of laser wavelength actions.

Technology improved. Prices fell to a level where more people could use more lasers in productive ways. Supermarkets looked to the laser as a tool for coding. Businesses found ways to use lasers on the assembly line. Factories used the laser as a cutting, welding and heating tool.

During the last 20 years the number of uses for the laser have proliferated and they continue to develop. Today lasers are used in numerous fields including medicine, weaponry, communication, scientific research, industry, energy and computers.

Lasers in Medicine

In medicine lasers are the cutting edge in more ways than one. At the forefront as an innovation, lasers allow surgeons to operate in situations where other types of surgery would be risky or impossible. Thanks to lasers, surgeons now perform delicate microsurgery in hard to reach areas like the inner ear, the eye, and brain. As important, lasers allow non-invasive surgery; a light beam replaces the scalpel formerly needed to cut into the body. As a result, hospital stays are reduced as healing time is virtually eliminated.

Among numerous other applications the laser is now used in surgery to:

destroy tissue that causes glaucoma,

seal together detached retinas,

remove growth from vocal cords

vaporize deadly cancer cells,

stop bleeding ulcers,

remove brain tumors without damaging tissue,

remove birth marks.

Laser light cuts through tissue by producing enough heat to vaporize cells. (Technically speaking a CO_2 laser operating in the infrared wavelengths, cuts by heating the water in cells turning it into steam. As it expands the steam explodes the cell.)

Its advantages are numerous: Since laser cuts cauterize thus preventing excess bleeding, the time in operating room is reduced. Also with the laser sealing off the small blood vessels less clamping is needed and there's less blood mop up.

In addition to being used to cut or burn away tissue, lasers have been tried in an amazing number of other medical procedures:

- to bleach out tatoos and birthmarks
- as an acupuncture tool
- to melt material for dental fillings
- to dissolve blood clots in the veins and arteries
- to strengthen scar tissue
- to diagnose cervical cancer

Research continues on other uses of the laser:

> diagnosis of various forms of cancer. Many cancers like those in the lung must be detected early to be cured. Now research at the University of South Carolina Medical Imaging Science is testing a new technique with lasers which may be able to detect lung cancer before the growths are one millimeter long. No conventional method of detection can do this.
>
> correction of nearsightness and astigmatism by reshaping the lens of the eye. Doctors at Sinai Hospital are attempting to use lasers to place burns on the front of the eye, a process which because it works so quickly is painless—which when healed will shrink tissue thus tightening the focus of eyes.
>
> slicing away of built-up material that clogs arteries.
>
> making tooth surfaces enamel tougher. By focusing great amounts of energy at a particular area, lasers can cause photochemical changes in substances.

Capitalizing on the capability of laser to focus energies to a minuscule point, scientists are experimenting with how it can be used to drill holes in a single human cell. By doing so the laser may prove to be a necessary tool in biological revolution. Using lasers in genetic microsurgery, doctors may eventually be able to correct birth defects, and even to clone human cells.

The prognosis for the future of the laser in medicine looks promising. Estimates show that by the middle of the next decade, one half of all hospitals will be equipped with lasers as half of all surgeons routinely use them.

Lasers in Communication

Lasers are helping ease the bottleneck that's resulted as the amount of information we need to communicate increases without a parallel increase in the means for transmitting it. Once again, lasers provide the answer to the problem as they begin to carry words on pulses of light rather than as electrical signals.

Lasers combined with fiber optics to speed up the transmission of data thereby impacting on the growth of the telecommunications industry. Fiber optical cables are replacing sound/voice cables.

Where sound transmission is limited—the telephone transmits voice frequencies at 1,000 to 4,000 hertz (cycles per second) and the TV signals at a frequency of about 50 million,—laser light waves transmit at 800 trillion hertz. And that figure will increase as soon as scientists figure out a new way to make fiber optic glass clearer so light waves can move beyond their present four-mile limit.

In addition to improving telephone communication, lasers are changing many of the other ways we send information. Among the new applications in communication:

> A light wave transatlantic cable being tested by Bell which will carry information from telephone conversation to TV shows.
>
> Laser projection TV screens which do away with the grainy and dim pictures inherent when ordinary light sources tend to produce.
>
> Projection systems that display holographic images suspended in space, now being studied by several manufacturers.
>
> Laser videos which don't wear out since they're read and not played.
>
> A system that combines laser and computer technology, already in operation in Japan where homes are linked with commercial centers. Without leaving their homes, participants shop, access timetables, stock quotes, weather reports. In the near future networks will be expanded to give people access to libraries, and to government officials, hospitals, out of town stores, and information networks. Experts foresee the day when the world becomes a global village with the linkage of present day laser-computer capability with satellite receivers that fit on one's wrist.
>
> Computer printers that use lasers to duplicate high quality typesetting and engraving.
>
> Optical communications systems already being used by TV newspeople.
>
> Lasers used in the calculating and memory units of computers so more information can be stored and it can be manipulated more rapidly.
>
> Laser audiodisc players which are improving the quality of sound.

Lasers in Industry

More than one hundred companies supply various industries with high-powered commercial lasers used for everything from materials working to measurement and inspection.

Lasers solve problems in industry, business and retailing. In the plant they give manufacturers unprecedented cutting and drilling power. With their unparalleled capacity to define a straight line, lasers also become ideal measuring tools. By delivering various amounts of energy at a precise spot, lasers vaporize material and thus drill through it. With a lesser amount of energy the laser instead of vaporizing can melt metal thereby welding pieces together. Or with even lower powers it can anneal or change the internal structure of a material without melting it.

Probably the greatest current use for the laser is to transform materials such as metal, rubber, plastic, cloth, and leather. In this capacity it helps shape ships, cars, jewelry, electric components—in general doing things other tools can't.

Also lasers are used in industry:

to cut diamonds and identify fake gems.

to read universal bar codes at supermarket checkouts thus reducing error, providing up to date inventories and data for marketing, accounting, etc. Also to read bar coded tags and send luggage to airline conveyor belts; 400 bags are handled per minute compared with the 75 capacity under the old system.

to align underground pipes and sewers, survey construction sites, level floors and ceilings, plumb walls.

to level and contour farmland, align crops, lay runways, highways in less time than conventional methods.

to strip graffiti from New York City subway walls, mildew from rare books, corrosion from bronze and stone sculpture.

to measure and inspect products coming off the production lines.

to aid in processing of cloth. The laser scans to find defects and even marks them.

to treat sewage; by monitoring the concentration of suspended solids in wastewater.

to locate the most useful wood in a log by guiding saw operator to get log into best position. Also with a computer, lasers calculate how to get the most wood from a log.

to drill tiny holes that are difficult to make in the conventional manner for aerosol valves, baby bottle nipples, cigarette filters, and circuit boards.

to balance wheels or gears of automotive vehicles.

to strip insulation from coaxial cable.

Lasers in Entertainment

In addition to laser light shows the technology currently or potentially offers these applications to make life more fun:

computer controlled laser machines that combine holographic video disc playback with laser scanning and sensing devices to help you practice your golf swing, softball throw or tennis serve.

holographic video disc players with laser scanning and sensing devices that provide a new reality to a popular pastime.

Argon or copper vapor laser light beamed at objects in crime labs and by detectives to reveal fingerprints left years before at the scene of a crime or even on objects that have been scoured.

Lasers in Scientific Research

Lasers with their unique ability to probe unknowns are blasting away the limits of our current knowledge.

At the United Technologies Research Center in Connecticut, for instance, researchers are using laser probes to get inside a rocket engine while it is running. By thus being able to monitor temperatures, scientists could improve the durability of NASA's space shuttle engines.

In addition to being able to reach minuscule areas unreachable by other means, lasers are also being used by scientists to:

measure ultra slow time scale, as slow as 1/7th an inch per hour provides researchers with new information about barely perceptible process in human cells.

cause photochemical changes in substances i.e. chemical reactions controlled by energy.

give a sharper picture of high speed events: a bullet penetrating a body armor.

measure tiny changes in scattered light to identify infertility problems, blood flow rates.

precisely measure atmospheric pollutants.

generate holographs. 3-D holographic pictures of viruses may be possible with x-ray lasers.

Industry Forecast

According to a study by *Laser Focus Magazine*, the commercial laser market reached $501 million in 1986. The 12% growth predicted for 1987 will continue with a predicted 16% to 25% increase each year.

John Naisbitt writes that he expects the laser industry sales to triple by 1990. This will have a major impact on industry, medicine, communication, education, entertainment.

The laser market appears to differ from other technologies, however. The cost of lasers are not expected to appreciably decline as the market for them increases. To the contrary, experts like Breck Hitz of the Laser Association of America does not foresee the price of lasers decreasing even though the sales volume will increase. Although Hitz sees the high price of lasers impacting on sales, he doesn't see any means for bringing the cost down. But he does feel the laser market will grow anyway. "People will see that the laser can do things that can't otherwise be done and they'll pay the price for that."

One exception is in the medical field. Experts agree that a least half of future laser sales will be in the health service field. The evidence can already be seen. For instance, a laser system used by opthalmologists that cost $70,000 in 1984 dropped in price in 1986. As a result, *Laser Magazine* predicts that the future prices of the more expensive systems will probably continue to fall. The magazine goes along with those experts who think that nearly half of the world's 14,000 opthalmologists will eventually purchase a laser if the price falls below $40,000.

Job and Career Outlook

"Robotics is the largest technology concept the U.S. has ever seen," believes Donald Jones of International Cybernetics. Within ten years a University of Michigan study forecasts robotics will imply 44,500 new engineers, electricians, computer programmers, systems analysts, installers, repairers, and salespeople. The Federal related occupations are among the nation's fastest growing, career category, rising 25-50% faster than others. This means that the need for laser/electro optics engineers and technicians will increase steadily.

A study by The National Center for Research and Vocational Education projects that by 1990 there will be a demand for 30,000 laser optic technicians with only 3,000 graduated by 1985. The demand for technicians will rise 60 percent by 1990 as compared to 1985. Many of those now involved in research and development will be employed by companies manufacturing and using lasers in areas of practical application.

Although there are 36 schools graduating 4,000 technicians a year, "we'll need 30,000 in the next five years," believes Daniel Hull, president of the Center for Occupational Research & Development. Laser Institute of America's Breck Hitz agrees that although there will be an ongoing demand for laser optical engineers and technicians, there is going to be a shortage.

Laser Optic Careers

If you want to work in the laser industry note first that job opportunities exist in two distinct areas: with the organizations that use laser equipment and with those that manufacture and sell laser equipment.

In the user category workers are needed who can purchase, install, test, operate, maintain and develop new applications for lasers. Those working with the companies that manufacture laser equipment will be more involved with the design, building and monitoring of equipment.

As already pointed out, lasers are used in a variety of industries including space and defense, manufacturing, medicine, scientific research.

With the exception of the medical field, industries need those trained as:

electro-optic engineers

electro-optic technicians.

Also needed will be:

sales engineers to demonstrate and explain lasers to potential customers

safety engineers and health physicists to set up and enforce programs and standards to safeguard workers from the hazards of lasers physicists who know of optics, and light-emiting properties of molecules and other particles for research, and development

chemists with special knowledge of lasers

computer specialists, programmers, technicians, operators who can integrate lasers with computers and computer aided manufacturing processes. Also those who can monitor and direct lasers

biolaser technicians.

In the medical field people will be needed with special laser knowledge:

doctors especially trained in laser medicine.

biolaser technicians.

laser nurse specialists.

Laser Electro-Optic Engineers

Laser electro-optic engineers work in a variety of environments including factories, plants, laboratories, hospitals and research centers. They can work for the military, for industry and scientific organizations.

Although duties vary, they most often include some or all of the following tasks:

designing, building and operating new instruments and systems

checking the efficiency of lasers in production lines

looking for defects

making changes to keep tools running smoothly

working with physicians, and scientists to find new uses

studying the limitations of lasers and trying to expand their scope.

Do you have what it takes to be a laser electro-optical engineer? To be successful you should enjoy working in several technical fields, like research, and be patient for there will be times when laser work becomes tedious or frustrating. Also you should be able to work both independently and as a team member.

Laser Electro-Optical Technician

Laser technicians must be able to manipulate all the elements of lasers and understand the properties of various media. The specific tasks performed by the laser electro-optics technician usually include the following:

troubleshooting and repairing laser systems and electro-optic devices

performing tests and measurements using electronic devices performing alignment procedures optical systems

preparing and reading shop drawings and schematics maintaining a laboratory notebook, performing data reduction and preparing reports

operating and/or calibrating laser systems, interferometers, spectrometers, monochromators, spectrophotometers, photodetectors, photomultipliers, optical power meters, calorimeters

performing optical inspecting and cleaning optical components

processing photographic film and plates

producing and reconstructing holograms

selecting laser and optical components based on optical, electronic and mechanical properties

fabricating and assembling components for laser electro-optic devices and systems.

Successful technicians have certain traits in common: they are genuinely interested in how devices and systems work, have a tendency to 'tinker' with machines and instruments, are interested in science, and like mathematics. They also possess a strong motivation to learn and are curious.

Training and Education

By 1987 the number of colleges, universities and community colleges offering bachelor level and two-year degree programs in laser electro-optics took their first steps to keep pace with the demand for skilled workers. They had initiated several four-year degree programs plus 35 community colleges two-year degree programs for technicians. In addition, at least three graduate programs became available: the Institute of Optics at University of Rochester, the Optics Institute at University of Arizona, and the Center for Applied Optics at University of Alabama in Huntsville.

Degree programs in laser optics are rare. Many colleges, therefore, offer courses in laser optics as part of electro-optical programs, physicians programs, electrical engineering or other optics related programs.

Bachelor degree programs in electro-optics engineering may include electronic circuits, logic analysis, college physics, calculus, FORTRAN programming, electro-optics, quantum electro-optics, geometric and fiber optics, laser theory, wave optics, applications of linear circuits, program with BASIC and COBOL electives in the humanities and management.

Of course to become an engineer in any category, you also need a license which you attain by earning a degree from an accredited engineering program or by having four years related work experience.

Because the field is so new and growing so rapidly, colleges and universities haven't had time to catch up in training people specifically in this area. So, sometimes with a shortage of qualified engineers employers hire generalists and train them on the job. Those who get hired most often have a general physics or electrical engineering background.

To prepare in high school for a bachelors degree, students need to take math, science, physics, chemistry, machine shop, biology, and drafting. English is also vital because engineers must be able to write reports, and give technical instruction.

In addition to earning a degree some employers suggest these alternate ways to get into the field: Work as an engineer in a field like electronics, optics, chemistry or material science that uses lasers to design tools or perform experiments. Then use your background in lasers to move into a job as a laser electro-optic engineer.

Or one could begin as a laser electro-optic technician and earn your engineering degree while working. Just two years study in a technical school, can help a high school student move into the laser industry. After that, work experience and further studies are the keys to becoming a laser electro-optic engineer.

Experience as a laser electro-optic technician may even be preferable as a first step toward the pursuit of an engineering career. Some employers believe technicians make the best engineers because they understand the practical problems of design and can relate them to the theoretical work of engineering.

"One thing seems to be clear, laser optic technicians are moving very strongly into the mainstream of engineering technology," believes Daniel Hull of the Center for Occupational Research and Development. "We'll need engineers that are trained in optical disciplines."

To prepare as a technician, get a degree from a vocational or community college that combines electronics, mechanics and optics. Only a few schools offer laser electro-optics programs; Among those that do is the Lewis M. Lively Area Vocational Technical Center in Tallahasse, Florida.

As for graduate programs, Hull explains that programs vary. The University of Rochester offers a traditional program in basic optical technology. The University of Alabama emphasizes optical devices, detectors and other courses that bring modern technology of optics into engineering practice. While the University of Arizona includes courses on "the blue skies" side of laser optics, optical computing.

For information on training programs, courses and materials contact: The Center for Occupational Research and Development, 601 C Lake Air Dr., Waco, Texas 76710.

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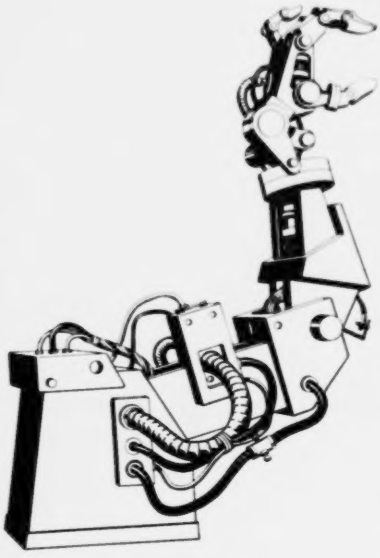
Chapter 4

ROBOTIC CAREERS

"As for the Future, your task is not to foresee, but to enable it."
—Saint-Exupery, 1948

The Industrial Revolution turned man into a machine, forced to do repetitive tasks. Monotony has enslaved him until today. Soon, however—maybe tomorrow—the last human machines will be set free. That's because the robots have arrived.



Dreamers say it's only a matter of time now until workers will shift from doing tedious and hazardous tasks to controlling the robots who work in their place.

Is the robot revolution really an evolution? Could these machines be a next step in the development of intelligence? Where man has failed to guard his environment and avoid holocaust and near nuclear disaster, will an ultra-intelligent mechanism give him a hand?

The role played by robots in our future society will be limited mostly by our imaginations. Technology experts have long said that if a dream can be dreamed sooner or later a machine will be designed to make it a reality. Never has this been more true than now. Gradually, robots may do more and more until one day in the 21st Century our robot slaves could free us from drudgery.

You'll only need a little imagination to get acquainted with these robots that are possibly on their into your life. Wake up to that special day in the year 2025 when:

> Your robot awakens you and serves breakfast. The milk in your glass was put in your refrigerator by a delivery robot that got into your kitchen by climbing the side of your apartment building via a track system.
>
> You step into your dressing room. Here, your robot taking on the role of valet, has shifted into position clothing selections based on the day's weather report.
>
> Looking in the mirror you get computer feedback: "It's time for a haircut." You position yourself in your salon chair as your robot, now a hairdresser, cuts your hair exactly the way you want. No longer need you be embarrassed when you get a poor trim because you always get the same good job each time. And you don't have to leave a tip either.
>
> While the robot snips, you dial the hospital to find out how your aunt's operation went. A robot answers and informs you that the operation was a success since it

> was performed by a robot. Controlled by a specialist surgeon at an institute 100 miles away, the operating robot is one of a team of telepresences that now regularly perform surgery. The telepresences are able to do things humans can't, like reaching areas of the human body that couldn't be reached before—the brain, eyes, and narrowest of blood vessels.
>
> Stepping into your home office, you review an employee suggestion from a newly manufactured robot that's just come off the assembly line. It seems the new robot has some ideas about how to improve robot assembly. Being a firm believer in the needed for employees to contribute to the improvement of the products they manufacture—even if the product is themselves—you take note.
>
> Next you study the monthly production report from Planet X where your company's largest manufacturing complex was constructed by and is now almost entirely maintained by robots. Your staff of only two human overseers ask for new projects since their work day is now only two hours long. That's because the robots being produced by other robots are more effective at their tasks.
>
> To get a "handle" on things—in more ways than one—you put on your work suit that's fitted with a thousand tiny receivers to pick up the sensory data being sent from the Planet X's moon. Via the telepresence on location, you are electronically transported to the moon. Through your fingers you feel the sensation you would feel if you were standing on the moon. You sense the vacuum of the space, feel the coldness, and brightness of sunlight. You don't fear being harmed by these sensations, however, since they've been mechanically screened with your comfort tolerance in mind.
>
> Similarly, during your lunch break, you put on a similar sensory suit and dial in your telepresent travel proxy at Big Sur. You relax as you listen to the surf, taste the salty air and watch the waves pound the sand. Oops, you almost get your feet wet!
>
> You call it quits after a long four-hour work day and head for your solarium. Your robot companion greets you with a glass of cool Reisling and "How was your day?"

Fantasy or not, your world may well soon look different as it's inhabited by robot attendants, workers, and companions. "Our civilization as we know it now will change," says James S. Albus, chief of the industrial system division of the National Bureau of Standard's Center for Manufacturing Engineering.

Robots on the Scene Today

But although it sounds as if robots alone will be changing our world, they are really just part of a much bigger, more complex system controlled by computers and monitored by humans.

This is particularly true in the primary arena for robots—industry. Although the totally automated factory of the future does not yet exist, we're moving in that direction. Robots play a significant part in the automotive plant where they insert windshields, rear windscreens and trunk lids, and apply insulation panels—among other tasks. At General Motors, the largest user of robotics in the U.S., 6,900 robots did these and other jobs in 1987.

Robots also improve productivity and lower costs in the aerospace manufacturing and in electronics assembly. A 1985 study forecasts that 14 percent of robot sales in 1995 will be for electronic assembly. By 1995, almost half of the robots used in electronic assembly will have vision capability.

Robert L. Vaughn, director of productivity for Lockheed believes that companies that don't use technologies like robotics "will be counted among the casualties of the new industrial revolution." For many of these forward thinking companies, robots are already playing a crucial part in the overall production process called automatic manufacturing.

"The long-range of potential of totally automated manufacturing is literally beyond our capacity to predict," Vaughn writes. He believes that automatic factories that can operate without human laborer and reproduce themselves "may change every aspect of industrial society."

U.S. businesses realize that if our country is to survive foreign competition we must boost production through the automation of manufacturing. Thus the U.S. government and major corporations and universities are investing millions to integrate and automate all functions in the design and manufacture of products.

This technology is directed by a central computer. Called Computer Aided Manufacturing (CAM), a programmed computer system runs factories and plants. In addition to creating designs, Computer-aided design (CAD) can also be linked with CAM to permit the preview of a simulated part or completed product before it is actually produced.

When a design is selected via CAD it is stored in the computer's data base so that upon command it reconfigures the manufacturing process by reprogramming the robots and automated machines.

Factories and plants run with CAD/CAM systems are directing robots to do a variety tasks. Robots weld, spray paint, cut cloth, load and unload materials; they also put together appliances, assemble computers, pack chocolates, and mine deep in the earth.

Without complaint they do the dirty jobs like arc welding and handle hazardous materials, often working in inhospitable environments. Robots are indispensable in the dangerous job of decomissioning obsolete nuclear power plants. For example, two robots were used to clean up the rubble inside the Three-Mile Island reactor. Others put out forest fires, and dispose of bombs and mines.

Robots have other roles:

> Robots like the remotely powered vehicle used by National Geographic Society to explore sunken warships, carry lights, take photographs, and use its arm to perform tasks.
>
> Explorer robots like America's "Viking" landed on Mars from where it relayed pictures, scooped up soil, and tested soil on board the spacecraft lab.

They carry messages back and forth inside underground mines or inside networks of ducts and pipes, like the micro-mouse from Battelle Laboratories. This robot mouse with infrared detectors eyes and six computer chip brain can find its way through maze-like passageways by trial and error and by inductive reasonings.

They serve as security and prison guards like Quasar Industries's Century 1 bullet-proof robot from whom it is impossible to escape. He can chase his victim at up to 20 miles an hour, disable him with a jet of laughing gas, blind him with a strobe light, and could be programmed to kill.

They are aides to the handicapped; voice-controlled robots take the form of wheelchairs with arms that can be manipulated to pick up objects. Robots visit hospitals to talk with handicapped children and to teach them certain skills. Robots called turtles teach people better ways of thinking and learning as they apply some of the learning skills discovered in robotic and AI research.

At home personal robot servants do the chores, everything from vacuuming the carpets to preparing dinner.

Why will the industry grow by ten fold in less than 20 years? Because robots are becoming cheaper and smarter. More capability is packed into smaller spaces thus the cost of manufacturing is declining. Also as the cost of labor climbs, robots become viable alternatives.

The '80s will be remembered as the decade of the robots.—*Manufacturing Engineer Magazine.*

The number of installed robots will grow sevenfold by 1992.—Institute for Graphic Communication.

Factory wide advanced forms of automation and robots is the *only* possibility—Harry Mackie of GCA Corp.

In 1990s there will be over 1 million home robots—Nolan Bushnell, founder Atari.

By 1995, 315,000 robots will be in use in America—Don Hegeland, managing editor *Manufacturing Engineer Magazine*.

The market for factory automation technology will reach $30 billion by 1990, up from $1 billion in 1980.—Robot L. Vaughn of Lockheed Missels & Space Company, writing in *American Metal Market*.

Sales in the domestic robot market will hit $255 million in 1988, with a projected $1.5 billion in sales by 1990.—Laura Conigliaro, Vice president, Prudential Bache Securities.

Over two million will be employed in robotics and CAD/CAM by 1990—Clyde Helms, president of Occupational Forecasting.

But despite this unprecedented economic potential, at least one expert believes the implementation of robot technology is proceeding slowly. James S. Albus chief of the industrial systems division of the National Bureau of Standard's Center for Manufacturing Engineering cites three reasons: the modest amounts of funding available for research and development; the enormous investment necessary to convert our present industrial base to robot technology; and the social and economic adjustments required with an increase in robot productivity.

The fact that the robots in RUR destroyed their human creators didn't help the early image of robots. Nor did the 1926 movie "Metropolis" in which a sinister female robot starred.

The concept of a mechanism that mimics life goes back to artificial birds that chirped in ancient Greece. In the 18th century, mechanical dolls served tea in Japan, and wrote letters and played musical instruments in Europe. Automation evolved more recently when mechanical toys and ancient water clocks were fused with electrical power and mechanical technology.

The earliest programmable robot was invented in 1954. In 1962 General Motors Corp. installed its first robot on an auto assembly line. GM's and other first generation robots had a stationary arm that could perform only a single task.

In laboratories all over country, scientists slowly developed more advanced robots. These machines with ever increasing human capabilities were able to accomplish more tasks, and more difficult tasks with each passing year. Eventually robots with sensory fingers will give robots a delicate sense of touch that make it possible for them to put parts and pieces together. Video eyes will enable robots to serve as inspectors with the ability to reject goods that don't meet prescribed standards. For example, a packing plant robot might be able to reject a piece of meat that is overly fatty.

Future View

By 1990 as many as 200,000 robots will be at work and industrial users will be spending over a billion dollars on new robots each year.

Robots are the ultimate machine tool. If you think about it, it's only logical that the next step in the development of tools should be the creation of one to take over the hazardous and repetitive jobs humans don't like doing.

In 1986, 10,000 robots took over the dirty, dangerous, undesirable jobs that humans dislike. In that year about 1000 firms in robotic and CAD/CAM industries employed 450,000 people. Today these employees continue to work in research, the planning, design, manufacture, selling and installation of robots and CAD/CAM systems.

Unlike conventional automatic machines, robots can be programmed and reprogrammed to perform numerous tasks, not just one repeatedly. They are controlled in two ways: As a telepresence robots are directed on a one-on-one basis by a human or autonomously under the control of a computer program. What sets a robot apart from a specific purpose machine is that robots are more flexible.

Flexibility and versatility are built into robots by means of computers, microprocessors, and various electromechanical sensing devices. Generally robots have an electro mechanical arm with a hand or claw used to pick and place objects. First generation robots repeat sequences of movements perpetually.

In the Beginning . . .

One definition of a robot is a mechanism that performs as a human, the concept of a mechanical person was created by a Czech playwright in his 1921 satire R.U.R. (Rossum's Universal Robots) result in solar-powered robots sunbathing when they need to regenerate energy cells.

The smarter the computer the more intelligent the robot. So, a primary goal is the development of a new language by which computers can better control robots' capabilities. Scientists are also working to improve the components that will allow the next generation of robots to perform more complex tasks.

Artificial Intelligence scientists are working on these enhancements:

> Optical sensing devices so that robot arms can sense shape and size. This will mean that robots can pick desired items from assortments, rejecting others.
>
> Three-fingered hands operated by tendons to increase dexterity not possible with bulky control motors placed on individual fingers.
>
> Increasing the accuracy, speed and difficulty of tasks executed by improving the robot's coordination between the hand (effector) and eye (sensor). This will enable robots to sense through pressure or touch and to then react predictably.
>
> Giving robots the capability of recharging their own energy cells.

Richard K. Miller writes in the book *Intelligent Robots* that eventually robots will be able to respond to a wide variety of sensory cues, and to learn by experience the skills they need to optimize their performance. "Such skills can then be transferred to other robots so that learning can be propagated rapidly throughout the robot labor force."

Just What Are Robots?

Considering the exciting things robots are—and will do in the future—it's easy to forget that they are just the next step in the automation process.

Intelligent Robots

In the next generation robots will be smarter, seemingly able to think for themselves. Seeing to that are the artificial intelligence (AI) scientists who are studying how to merge computer language and operating hardware so the robot can better imitate human characteristics.

AI is one of many technologies related to robotics. Others include machine vision and simulation—both being studied to enhance the capabilities of robots.

We now have robots that perform by rote or respond to remotely controlled commands, but the goal is to create thinking robots that can see, hear, feel and obey. The elements that will produce such results are now being researched and developed by AI scientists.

Advances in AI are linked directly to the computer's capability which is increased as technology improves. Each generation of computer aims at great compactness. The first computers used vacuum tubes, the second relied on transistors, the third on integrated circuits.

Now the fourth is just beginning to use large scale integrated circuits. These feature vast memory banks expected to work at one thousand times the speed of today's circuitry and contain 1,000 times as much information. Fifth generation computers will mimic human reasoning. As thinking machines these robots will be able to solve problems and then take appropriate action.

One system being explored mimics human brain structure and includes a degree of programmed free will.

A Career in Robotics

Some experts predict that by the turn of the century the world robotics industry will match the automobile industry in the numbers they employ. Also, uses of the robot will increase in medicine, in the military and particularly in industry.

As the new smaller and less expensive robots proliferate, growing numbers of people will be needed to install, repair and maintain them.

The manufacture and servicing of robots will produce an enormous demand for mechanical engineers, technicians, computer programmers, electronic designers and robot installation and repair people," believes James S. Albus, chief of industrial systems division of the National Bureau of Standards Center for Manufacturing Engineering.

And robots are just one of the new technologies that will automate our factories and offices. Although robots will perform the tasks, complicated systems will be needed to control them. CAD/CAM, Computer Aided Design/Computer Aided Manufacturing systems are one answer already automating and integrating the functions in the design and manufacture of products.

Robotics now is largely a research and development field. Like other high technology fields, the future of robotics depends on funding; currently the federal government is providing that cash flow whether or not funding continues is uncertain but most experts predict it will. They reason that as the U.S. shifts from an industrial based economy to one founded on providing information, robotics will grow in importance. In fact, some analysts predict that the value of robots installed in factories will escalate to $2 billion by 1990.

Jeffrey A. Burnstein, director, marketing and public relations of the Robot Industries Association believes more careers in robotics will be related to services. He refers to a *Fortune Magazine* article (Sept. 14, 1987) "Invasion of the Service Robots" which says we're seeing the development of the service robot technology. "The article may overstate the case as it is currently but, down the road by year 2000 and after robots helping the handicapped should become a big industry."

However, "It's not possible to understand the U.S. robot picture without looking at imports," writes Jan Bone in the book *Opportunities in Robotics Careers*. The author quotes U.S. Commerce Department expert John Mearman as forecasting that the number of firms in the industry will shrink, which means the business will tend to concentrate in larger ones.

Bone warns that if you're considering a robotic career, "there are currently fewer robots in U.S. factories than you probably realized." This could impact on your job search in that "a degree or certificate in robotic technology is probably not automatically going to guarantee you a job."

Offering constructive advice Bone suggests: "take a good deal of responsibility for learning what is going on in the industry and keeping up with developments" (see Bibliography).

In the years ahead, among the promising categories are those for specialists to design, program, install, service, repair, and adapt robots to human environments. In addition, support personnel will be needed—technicians, teachers and trainers.

Here are descriptions of some of the major career opportunities in robots in the years ahead:

Robotic/Application Engineers

Already many *Fortune* 500 companies are investing in robotics machinery. In the future we'll see increased integration of the robotic into the whole manufacturing process. Robotic and applications engineers will be needed who understand integrated factory systems and manufacturing systems.

These specialists are familiar with the electronic and mechanical features of robots, and are able to integrate robots into the traditional manufacturing operation. This involves understanding the programming of computers, and the devices that control robots. Often these specialists are proficient in design electronics, automation, and software applications technology.

Electrical Engineers

These engineers design, test and operate robots and CAD/CAM systems. Their specialties can include integrated circuits, automation control systems, energy and power sources/uses, electromagnetic fields, infrared/thermoradiation technologies, electronic interfacing/linking terminals.

Mechanical Engineers

Mechanical engineers assist in the design, construction; and manufacture of robots. They determine materials, tolerances, and specify gears, linkages, motorized parts, and gripper devices. They are familiar with such devices as hydraulic and pneumatic systems.

CAD/CAM Engineers

Experts estimate that over one million CAD/CAM engineers will be needed by the year 2000. These specialists either have experience in or have studied computer sciences, manufacturing, engineering, electronics and mechanical engineering or combinations. They are authorities on equipment and methods used in the factory automation process.

Industrial Engineers

These engineers specialize in factory layout, how to maximize production by optimal arrangement of robots, computers and personnel. To do this they must understand the capabilities of robots and how they can best fit into the environment. They also understand and implement safety measures.

Manufacturing Engineers

The function of these specialists lies between that of product design and production. Manufacturing engineers develop and coordinate the production methods that most efficiently produce products. Leading the design engineering team, manufacturing engineers often are responsible for the implementation of CAD/CAM system, and recommend robots or machinery for purchase/use. The multifaceted nature of their task, calls for wide knowledge of the design, tooling, materials, quality control and fabrication tasks.

Technicians

In the past, technicians usually took two-year programs as opposed to engineers who graduated from colleges or universities with four-year degrees. Today engineering technologists earn four-year degrees and earn salaries close to those of engineers. In addition, two year programs are also available for other technician categories including those in repair and maintenance technology and program applications.

The two major categories of programs for technicians are in manufacturing technology which supports engineers, and in industrial technology which supports management. Two- and four-year programs are available in both disciplines, each with similar and different courses. Industrial technology programs emphasize management training, requiring fewer mathematics and sciences courses than does the manufacturing technology programs.

Robotic Technician

This technologist takes over where the engineer leaves off. He takes the design worked out on paper or computer and sets up and programs new automation. To do so he may test the program, install it, and then troubleshoot as he works to maintain the robot, computer and CAD/CAM systems. To be able to fine tune the robot's components, this specialist must be familiar with machine and hand tools, electronic measurement, calibration devices, parts, materials, safety measures.

Robot Service Technician

William H. Weiss of Goodyear Tire & Rubber Company, estimates that by 1990 there will be a shortage of 100,000 technicians to service automation equipment including robots.

Until robots are used to repair other robots, the industry will need service people to keep machinery functioning smoothly. Preventative maintenance will become more and more important. In addition to industry, service technicians are needed at trade shows, conventions and exhibits like EPCOT where robots star in automated exhibits.

A variety of other programs prepare students for the role of technician. Among the technician specialties:

lab robot technologist,

robotics service and technical installation,

biomechanical robotics,

electromechanical,

hydromechanical,

robot psychologist.

Educator-Trainers

Trainers must be found to teach technicians how to install and maintain the 100,000 robots predicted for industry by 1999, in factories, corporate offices and plants.

Their job is to introduce technicians, factory workers and management to the capabilities of the robot. Educators are in a good position to get an overview of the entire field which puts them in a position to become consultants. To teach the mechanics of robot installation and service you must be able to overcome your students' resistance to the machine, dispel their fears and convert skeptical people to enthusiasm for the value of robots.

Trainers teach managers to support the new technology, instruct engineers on how to program and interface robots and machinery, and work with operators and maintenance to set up smooth-running operations.

Robot Consultant

Unlike a manufacturer's representative or salesperson, a consultant is familiar with various products on the market, knows the advantages and disadvantages of each and is able freely to recommend the best for a client's particular situation. Typically a consultant surveys a client company to determine the most practical uses for an industrial robot and then arranges for the installation of robotic equipment. He or she can also train company personnel in the robot operation and maintenance.

CAD/CAM Designer-engineer

This specialist uses a computer screen to design and redesign equipment parts. He or she is able to thus visualize the parts being designed like a draftsman does on drawing paper with greater speed and flexibility.

Other robotic careers include these which are now or may soon will be calling for specialists

artificial intelligence psychometrists, those who test the IQ of machines

energy auditors to track the energy expenses of robots in production. Working with product engineers, these specialists must be proficient in the use of various energy monitoring devices

robotics industrial hygiene technicians

robotics quality assurance inspectors

fund raisers for robotic societies, venture capital for R&D

robotics publishing

industrial-robotic psychologists

computerized vocational training technicians and image processors who develop programs that merge computer aided design with word processing for training and user's manuals.

For more information on careers write for these two phamphlets: "Making Your Career Choice Robotics" and "Robotics Career Opportunities" available from the American Society of Manufacturing Engineers, Robotic International, P.O. Box 930, Dearborn, MI 48128.

Education and Training

Fifty percent of the robotics jobs created before 1990 will require at least a community college education. Fortunately, the number of educational programs offered is expanding both in technical schools and in universities and colleges. Two- and four-year programs range from basic robotics mechanic associate degrees for entry level jobs to advanced master's and doctoral degrees in electronics for research careers.

Many of the programs offered in robot technologies are sponsored by robot manufacturers including the General Motors Institute in Flint, Michigan.

Two-year community college programs offer associate degrees for careers as application engineer, robot operator, and installation technician. Although some people tend to look down on the two-year technical institutes, they are often better equipped to teach robotic concepts and maintenance than four-year colleges. Numerous vocational-technology programs offer courses that cover the theory or robotics. Michigan's Oakland County School District was the first vocational school to offer a robotics training program. The 64-hour training unit provides students with a solid base by including physics, electronics, computer science and machinery design in its program.

In this course as in many others around the country students build their own robot. By doing so they pick up important knowledge in a number of fields and also acquire valuable skills. Among these, the ability to work as part of a team, in communication, problem-solving, planning, record keeping.

Zenith's Heathkit company offers a complete at-home training program. For a brochure about it write to Benton Harbor, Michigan 49022. Other companies advertise in *Popular Science*, *Robotic Age* and *Computer & Electronics* magazines.

Fred D'Ignazio in his book *Working Robots* writes that there are other reasons to study robots. "Robotics offers many career opportunities, since it is a focal point for some of the most pervasive new technologies being developed in our society such as microelectronics, computers and AI."

Some schools don't yet offer programs formally called CAD/CAM or robotics but coursework in electronics, pneumatic, hydraulic systems, mechanical systems, instrumentation technology, engineering, drafting, mathematics, industrial manufacturing, microprocessing, and fiber optics add up to prepare you.

Two schools offering courses in orthotics and prosthetics technology are Delgado College in New Orleans and 916 Acrea Vocational Technical Institute in White Bear Lake, Minn. Other two- and four-year programs are offered at New York University, Northwestern University, and UCLA.

Forerunners in the academic world are MIT, Stanford University, and Carnegie-Mellon. Most of these are well funded by corporations, government or both which means students are taught by professors who are the country's experts.

At four-year universities such as Stanford, Carnegie-Mellon and the University of Rhode Island degrees can be earned in robotics engineering. Most of those enrolled in these programs studying a combination of disciplines that include robotic hardware, software and fabrication.

In addition master's and doctoral degree programs are offered in various engineering disciplines including electrical, industrial, mechanical and computer-aided-design.

For the current North American directory of robotics educational and training institutions that includes listings of schools offering robotics degrees, and courses write to Education and Training Division, Robotics International, Society of Manufacturing Engineers.

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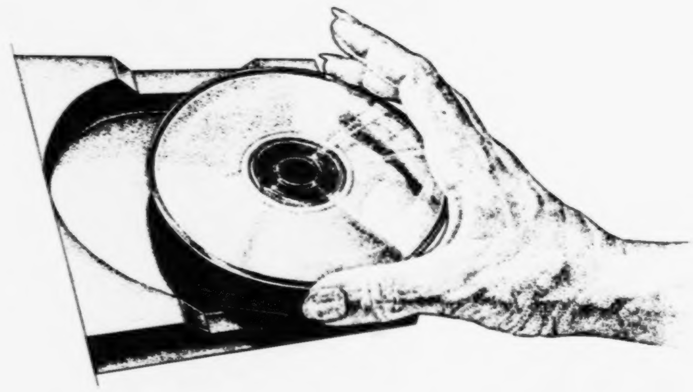
Chapter 5

INFORMATION TECHNOLOGY CAREERS

"Never let the future disturb you. You will meet it if you have to, with the same weapons of reason which today arm you against the present."
—Marcus Aurelius, 2nd Century

Information Technology sometimes called Telematics is emerging as the mega industry of the 21st century. Instead of manufactured goods, the main product of the United States in the 1990s and beyond will be information.

Today more Americans work in information-related jobs than in manufacturing and agriculture combined. A century ago fewer than 10% of the American labor force were doing information work, now more than 50% are engaged in it. Information work may be keeping 45 million workers by the year 2000.



One of the major problems inherent in the change from manufacturing and agriculture to information is the difference in the amount of the product to be handled. The volume of goods we manufacture, grow and transport to market is small when compared to the mind boggling load of information that we'll be making available to the world. There's so much information to be manipulated, in fact, that our main effort must be directed to reducing its size if we're not to be inundated; the smooth operation of society depends on it. After entering data onto computers for 40 years we need to now focus attention on making use of that information. We need to pull the lever as Marshall McLuhan might say. He called the mechanisms that store, retrieve and transmit information "the levers that move Western culture." He even went so far as to say that the technology that handles information "overshadows content."

Information Technology gives us the lever that makes the storage of information and entertainment, such as videocassettes, possible.

To accomplish that, information technology must pull together various communication technology threads. The various systems for storing and sending information—the elements of basic telephony, data processing, hardware, content formats for input-output, transmission storage and processing—must come together in one workable system. But how?

Information Technology has merged with the telephone, telegraph, telex, data processing and the broadcast media. This has been made possible by recent advances in microelectronics, fiber optics, digital technology, and such techniques for collecting storing, displaying and transmitting information with the use of cables and satellites. Primary is the emergence of digital technology—the common link that now unifies previously divergent technologies.

The digitization of information is one of three developments that has caused "an explosion of technological and social innovation on a scale not seen for many decades, perhaps not since the Industrial Revolution," writes Tom Forester in *High-Tech Society*. (The other two trends he cites are the decline in the cost of computers due to the development in microelectronics; and the deregulation and privatization of public monopolies by governments especially in the field of telecommunications.)

By using a digital language all information can be reduced to the same type of computer code. And because information is coded in the same form it can be used anywhere within a system. Which means that instead of having to convert computer codes into the continuous signals that telephones use, now *information* can be translated into electric signals. This capability offers a primary advantage: electronic signals can be stored, processed and transmitted quickly.

With this electronic signal conversion capability, separate technologies can now be linked together to form a single system. And with a single system, it's possible to collect information in one place, work on it at another location, and store it at a third. Also with this linking technology the images stored in videos can be mixed with the words prepared on a computer. The technology also enables far-distant computers to be linked by orbiting satellites so they can communicate with each other.

A simple way to get an overview of the complex Information Technology industry is to picture it as the umbrella under which once separate endeavors huddle: Information Management which processes information, and Telecommunications which transmits information.

Also the umbrella of Information Technology shelters the numerous offspring of both of these parent industries.

- Information Management
    - micrographics
    - filing systems
    - computers
    - videotext
    - optical and laser discs
- Telecommunications
    - telephones
    - electronic mail
    - video- and teletext
    - video- and teleconferencing

- networks
- cable TV
- satellites

Computers

- data processing
- hardware
- Local Area Network (LAN)

Each of these Information Technology subdivisions together with their offspring will be discussed in the chapters that follow.

The Impact of Information Technology

Information Technology has penetrated to the core of our professional and personal lives. The technology "is at the synapses of our national defense strategy, tilting the balance of international trade, employment levels and politics . . . once shaped into systems, the potential for positive or negative socioeconomic and geopolitical shifts is mindbending," writes Harvey L. People and Bernard Goldstein in *Information Technology: The Trillion-Dollar Opportunity*.

Even if they don't hold jobs in the information industry itself, most working people today find themselves in offices that have been vastly changed by the emergence of information technology. That's because the products of a number of separate industries involving information technology have come together to change the way offices conduct business. Now more fully automated, these offices of tomorrow combine the products of a variety of industries: telecommunications, computers, word processing and other computer-related systems.

In the office of the future, computers, telephones and other equipment are linked into a single system onto a local area network (LAN), which is a means to interconnect devices in the same room, or between one or more buildings. Using fiber optic, laser, microwave, satellite and hard wire technology to relay both voice and data, LANs serve as catalysts in offices, turning computers and related peripherals into a single integrated facility. Even more will be possible with the Integrated Services Digital Network (ISDN) which became available in 1987. This device expands transmission capability by integrating all kinds of digital input—voice, video and data—into one system.

Careers in Information Technology

If you work with computers or with telecommunications devices, the classification of your industry is obvious. However, when one or more systems are combined in the workplace, job categories blur. Thus, in presenting the future career options without duplication, we're dividing jobs into one of three categories: Telecommunications, Information Management, Computers.

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Chapter 6

TELECOMMUNICATIONS CAREERS

"I believe the future is only the past again, entered through another gate."
—Sir Arthur Wing Pinero, 1893

Where a hundred years ago it took a horse-drawn carriage ten days to go 400 miles, today that distance is bridged in one/tenth of second. Replacing the wheels, rails and wings that conveyed us over the miles in the past is a revolutionary new transportation system—the telecommunications network.

Thanks to the emergence of the telecommunications network people are able to access any information they want any time, thus they become less dependent on cars, trains and planes. By being able to relay our voice, image and written (or drawn) ideas across town—or across continents—we'll need to travel less.

"This intelligent network is our society's key link to the information age," writes John S. Mayo, executive vice president of Bell Laboratories in his essay in *The Information Technology Revolution*.

Telecommunications has been defined as the electronic media used to distribute or communicate information over long distances. Systems include: telephone, videotext, satellite broadcasting, electronic mail/fax and cable tv.

The Telephone Grows Up

The birth of the telecommunication industry goes back to Alexander Graham Bell's invention of the telephone in 1876 and his organization of the Bell Telephone Company in 1877. For over one hundred years "Ma Bell" ruled the long distance network, carefully holding onto its monopoly to interconnect the nation's telephones.

As a result of the Federal Communications Commission's Carter-Phone decision in 1968, the telecommunications industry was opened to competition. AT&T's monopoly crumbled in 1984 with the Justice Department decision calling for the divestiture of the telephone company. Big changes followed in the industry as new private and public networks were launched.

Now companies can build their own private networks to save money on their telecommunication charges. With this option private and public networks have skyrocketed and so has the need for new expertise.

Enormous Potential

Projections indicate that the worldwide market for telecommunications in 1993 will surpass a trillion dollars—which exceeds the size of the U.S. gross national product.

The potential is enormous. "It is not farfetched to assume that 5-10 percent of a company's expense will be on telecommunications and that this business will replace the automotive industry as the world's largest industry," writes R. J. Murphy in his book *Telecommunications Networks*.

Murphy believes that growth will depend on whether governments at the local, state and federal levels see telecommunications networks as an alternative to mass transit. For instance, Murphy points out that Houston could solve its downtown transportation problem by putting money instead into a great telecommunications network. By doing so the need for employees to travel downtown to their employer's facilities will be diminished. With fewer people commuting downtown congestion will decrease.

But the most exciting prospect in telecommunications is the introduction of artificial intelligence (see Chapters 4 and 8). When the two are brought together, the tie between the computer and the networks that connect users will be solidified.

"When that happens we'll be able to see, listen to and talk to anyone in the world either directly or via stored information. The consolidation of this one to one communication will have the emphasis of both the computer and telecommunication industry during their next five years," Murphy believes.

If Murphy's forecasts come true, then the next 10 years will be the most exciting era for telecommunications "after which this industry is going to be the dominant industry in the world, displacing the automotive business as people become less dependent on one form of transportation and more dependent on total communication."

How Telecommunications Is Changing Our Lives

Just how does the promise of this technology translate into our everyday lives? Already we're beginning to see all around us the benefits of telecommunication technology. The following innovations have recently been introduced or are about to be:

Videotext—a two way interactive TV system opens the way to electronic mail, teleshopping, telecasting, electronic libraries, and innovative audio visual applications like photographic editing.

Message wristwatches—instead of hearing a pocket beeper you can see a message displayed on your digital watch.

Airphones—while in flight you can now make air to land phone calls and charge them to your credit card.

Teleshopping—by looking at a special TV channel you can view items and order them by calling a toll free number. Although only 29 home-shopping programs are presently available, demand is about to create a $1 billion industry.

Personalized phone numbers—like auto licenses you can now get for about $50 a month service charge phone number that delivers a message about you or your interests.

Electronic mail—instead of phoning, private systems now make it possible for you to send messages from your computer to someone else's.

Telephone call routing—instead of redialing or reaching a busy signal your call is routed to an automated attendant. This computer-based machine answers and then routes you to your party or to a live operator.

Person-phones—With a telephone number assigned to you personally rather than to a telephone set, all calls are automatically routed to you as you move along the itinerary you've entered into the database.

Call management service—by seeing the number of the caller displayed or by hearing a set ring sequence you know who's calling before you pick up the phone.

Ghost calls—in the near future you won't have to be present to make a phone call. Recorded voice messages could be delivered at specified times to specified telephone numbers.

Teleconferencing—with more widespread use of this technology you'll save time, money and energy as you relax at home or in the office instead of traveling across the country or continents.

Energy savers—with the broader use of digitally controlled systems that control energy consumption, you'll never again shiver or swelter in a hotel or motel room.

Teleterminals—with the coming boom in this technology you'll have your own electronic home information systems. With it you'll be able to shop from your home, and link your home with energy utilities so you can control your energy usage and improve home security. This system will also eventually enable you to send written information at the same time you're talking on the phone.

Telecommunication technology is being used in another significant way: as the king pin in the office of the future. To create the automated office, business administrators are reorganizing and restructuring their operations around telecommunication systems. By doing so, they recognize that much of their competitive advantage rests on maximizing their use of the telecommunications technology.

First and foremost of the potential telecommunications offers is as an instantaneous link between people. With a telecommunications system as an ally we'll let our keyboards do the walking—and traveling—around the nation and world. Rather than delaying the delivery of our expertise by hours or days, we'll be able to react instantly by simply pushing buttons. Soon, we'll make the modern equivalent of the choice our grandparents made when they climbed abroad the transcontinental railroad rather than the pony express. Once again the need for the speedy delivery of our knowledge will demand that we use the most rapid means of transport—telecommunications.

The Role of Fiber Optics

The materials used for transmitting information have played a large role in the evolution of the industry. Old forms like copper telephone wire, radio signals and ground antennas are giving way to new conduits like glass fibers, microwaves, satellites, laser beams and the pulsating digital language of computers.

The marriage of laser light and optical fibers are key. Optical fibers are the hair-like highways along which light pulses travel with their cargoes of information. Because optical fiber is thousands of times thinner than copper wire, it can carry many more signals—10,000 as many. This means that where a copper circuit carries 22 telephone conversations at once, the equivalent fiber optic circuit carries 8,000. In addition to moving more information, optical fiber offers other advantages: it transmits both voice and pictures, is easier to handle, is immune to electromagnetic interference thus provides a clearer signal, and may prove cheaper than copper cable.

These advantages are making the use of conventional copper cable for telephones obsolete. By the year 2000, copper cable will be a thing of the past.

Although telecommunication is the dominant market for the optical fiber industry, the technology is now or will shortly be used to do other things as well:

transmit images from inside factory furnaces via optical networks

monitor pressure developed industrial processes

inspect products rolling off assembly line

funnel information to control computers

measure chemical spills

guide missile devices

link submarines and offshore oil and gas rigs with land bases over longer distances less expensively

carry international traffic, thus opening a "global digital highway" across the Pacific and Atlantic Oceans

In 1990 fiber optic industry sales will jump from the $300 million 1982 total to $1.5 billion. By the year 2000, forecasters at Kessler Marketing Intelligence of Newport, Rhode Island, predict industry sales will be ten times as high as in 1984. Within the next decade most of the world's telecommunications networks are expected to convert to fiber optic technology, creating a trillion dollar market for electro-optic systems.

In addition, trans-oceanic fiber optics links are expected to become stiff competition to satellite communication. More than 20,000 miles of fiber optic cable presently crisscross the United States.

The market for fiber optic products, now worth $105 million, will grow to a total of $845 million by 1996. This market includes computer communications, data processing and office-factory automation.

Growing numbers of firms will opt for fiber optic data communications and move with the developments in integrated opto-electronics. To give the industry a further boost, forecasters at the International Resource Development Inc. predict that by the 1990s companies will emerge to supply fiber optic terminal equipment to business and to consumers.

Telecommunications Careers

The two major areas in the telecommunications industry where jobs and careers are found today are with those who manufacture equipment and the carriers that provide transmission service. Although transmission services include cable TV and satellite services, it's the telephone industry that makes up the largest segment of the industry.

Major operating companies and independent local telephone companies "account for as much as 90 percent of the total number of job openings in the entire telecommunications field," notes Texe W. Marrs in his book *High Technology Careers*.

Some of the job positions in this area that look as if they will expand in the future are:

- telephone equipment repairpersons
- line installers and cable splicers
- administrators and managers

Just as with the carriers, jobs in the other segments of the industry fall into four broad categories:

- technical
- engineering
- management
- sales and marketing.

Technical jobs of the future include switching technician, cellular installer and technician, network analyst, industrial designer, tele- and cable-shopping installers. Here's a rundown on some of these positions.

Network Analyst

Of the numerous current job titles in the technical telecommunications industry, none hold more promise for the future than that of network analyst. Until deregulation, there seemed little reason to fathom the workings of the network.

Today, however, companies putting in their own telecommunications networks need the advice of someone who can plan a system that meets objectives. This takes a person who understands the relationship of the network to the environment, who is familiar with the technical aspects of telecommunications transmission, traffic and switching.

Even though vendors provide systems engineer support, they may not take their customer's objectives fully into account. The network analyst does; he or she determines the switching configuration for optimum routing based on the users' needs. These specialists interpret and arrange a network with an understanding of objectives.

At first the job of selecting and evaluating transmission and receiver systems will be done by consultants; in time, however, consultants will be replaced by departments set up inside an organization.

Industrial Designers

When videotext enters its third phase of manufacture in the 1990s, the production of specialized equipment will be essential to continuation of the industry. Users will demand design customized to personal specifications. The only way this will be accomplished is through CAD, which will require the services of industrial designers skilled in computer applications (see Chapter 3).

Telecommunications Engineering

In the future, as now, it's expected that there will be a great demand for engineers in telecommunications. Not only will they handle the technical aspects of telecommunications but also will serve as liaison between customers and their organization's staff.

Other duties will vary. Among the tasks expected to fall in the engineer's area:

- designing circuitry and logic systems
- handling problems regarding installation
- programming and maintaining systems
- training field service technicians
- providing marketing support by answering technical questions
- writing conversion programs
- monitoring software switches
- managing other engineers

Especially after the emphasis of videotext shifts to the introduction of more sophisticated and specialized equipment, the need for engineers should skyrocket.

Telecommunications Manager and Vice President

Like any manager, this executive supervises the operation of a department, prepares an annual budget, monitors efficiency, updates and oversees maintenance of equipment, and trains personnel.

At a higher level, the communications vice president is responsible for telecommunications policies and objectives, and for monitoring costs. To make sure the telecommunications system is cost effective, he or she works closely with computer, budgeting and purchasing personnel. Generally, this executive report to the Communication Information Officer (see Chapter 6).

Agents of Change

This management position coined by Diane Butler in her book *Futurework* refers to a new breed of managers who live in two worlds—the technological and the humanistic.

This manager's job is to help employees make the transition from an old familiar world into one of high-tech office automation. To ease the way, and thus insure the highest possible productivity, the Agent of Change balances technological, social and environmental concerns. Then, he or she designs a system that increases the possibility that users will be able to work in an interesting and autonomous way. To do so, this guide to innovation consults with employees, encouraging them to voice their desires.

Since this occupation is just evolving, there are few if any programs to prepare one. So, for the moment, these specialists are coming from such related professions as labor relations, social psychology, or ergonomics. Some also bring to their position skill in data processing, information science, and computers.

"We are always fundamentally influenced by the tools we use," Butler points out. As with the introduction of cheap automobiles "so too, the automated office will initiate an equivalent upheaval in future forms of organization. Guiding the revolution, Change Managers will be around for some time to come."

Information Brokers

Since the purpose of videotext is to provide information, those who provide the content for the system will be in the greatest demand over the long term. Information specialists will be needed to deliver speccific information to specific markets. To do so effectively, they will have to take into account the differences inherent in videotext versus other media.

In addition to creating pages of information, information brokers may also take on the job of marketing information, and of consulting with clients on how to set up information, and on which equipment to use and to purchase. These specialists will also train others to be consultants or to work in-house for an organization.

Because this field is so new there are as yet no organized programs. Most people entering the field get their training on the job. Certain strengths help open the door: the ability to plan programs, to design systems, to edit and update data, to design graphics, to manage, supervise and train others.

Sales and Marketing

"As the technology becomes more elaborate and diverse in its applications, clients tend to need more information and problem-solving on an ongoing basis," writes Sharon Silver in the *Washington Post*'s 1986 Fall High Tech supplement. As in customer service, experts foresee opportunities soaring in marketing and sales. Among the jobs with a future are those in data communication sales, commercial management of customer problems, and international marketing.

More Jobs

The future also looks promising for telecommunications consultants, especially those specializing in alternative telephone services and in office networking. There will also be a need for telecommunications lawyers and paralegals to give advice on regulations, to negotiate and draft contracts, and to offer expertise on joint venture licensing.

The Omni Future Almanac sees the creation of new job categories in the coming decades. In addition to telecommunications consultants they see a demand for alternative telephone technologies consultants, office networking consultants, and tele- and cable-shopping installers.

In the area of satellite broadcasting and communication satellites, the future looks bright for electrical and mechanical engineers. In videotext, many of today's jobs should also be around tomorrow: software designers, systems analysts, programmers, data base managers, marketing and sales personnel, editors and writers.

Opportunities in Fiber Optics

Optical Engineers

A surprising number of companies and businesses specialize in fiber optic communication cables and components. Those that do need specialists who can design the systems that maximize the potential of fiber optics. Optical engineers, who combine the disciplines of engineering and physics, understand electronic communication and its implementation through glass fibers.

Since the industry is new, there are as yet few B.S., M.S. or Ph.D programs in optics. However, an increasing number of electrical engineering and physics departments offer courses in electro-optics. One of the few two-year programs in electro-optics available is offered by Washington D.C.'s Capitol College. Capitol College's president Dr. William Troxler believes those who want to get into the field should have a broadly-based training, rather than one specifically focused on fiber optics. "Students need a grounding in electronics or electricity before they get into the specific," he believes.

Carolyn Hinerman, general manager of the NRI Group, a leading contingency search firm, believes the ticket into a fiber optic career is a degree in software engineering. "Software engineers are more marketable. Since they do more things, their chance of getting a job is greater." She explains that software engineers do everything, except work on hardware, as they develop networks and the links that connect them.

In addition to a core program of courses in mathematics, physical sciences, engineering, sciences and humanities, the Optical Society of America suggests extra courses. Their literature makes the point that an extra course or two in computer science or mechanical engineering may prove worthwhile for the prospective optical engineer.

"We're in transition now as the uses for fiber optics expands," observes Dr. Troxler, in summing up the state of the industry. "People are only just beginning to look at how the devices they now use can be redesigned to take advantage of fiber optic technology. As they see these possibilities, a whole new range of applications will open, not just at the technical level but also in engineering and in physics."

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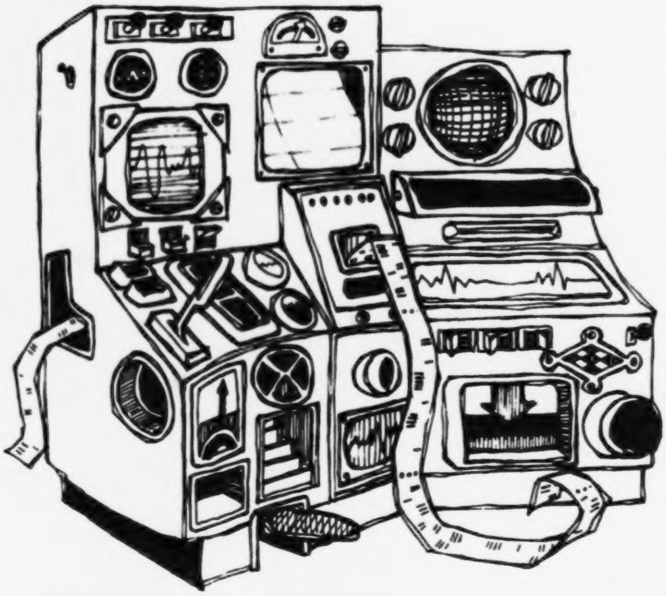
Chapter 7

INFORMATION MANAGEMENT CAREERS

> *"He that fears not the future may enjoy the present."*
> —Thomas Fuller, M.D., 1732

According to some definitions, information management is the data storage and retrieval component of the complex information technology industry. Information management encompasses both telecommunications—the transmission of data—and computer systems—which create and manipulate data.

Information management has come a long way since human beings first kept track of their grain inventories on stone tablets. Through the centuries the flintstone and chisel have been replaced by computer keyboards and voice synthesis; stone and papyrus have given way to microfilm and optical discs.



With people's limitless inclination to create data, it takes increasingly more sophisticated technology to help store the input in a way that can quickly and efficiently be retrieved as needed. As we all know, creating information is one thing; being able to put your hands on it when you need it is another. But if keeping track of things was tough in the past, the future will be worse. The technology for data storage and retrieval has not kept up with the information revolution, which has brought us more data than we can track.

"We've spent the last 40 years processing data," COBOL computer program inventor Rear Admiral Grace M. Hopper, U.S. Navy (retired), summed up. "Now it's time to start using that information."

Those involved in Information Management are working to make sure we do. As they work, some see the ultimate goal: the day when we'll be able to punch a question into our terminal and then get all the information available on the subject presented in a variety of means: voice, text, video and other visual images. Happily, the time when we'll have such a tool isn't far off. Already the hardware to supply this quality and quantity of information is available; the software—or content—is now being developed.

A complex of technologies makes such an application feasible. Among them is the major information storage system, micrographics, which is the technology that encompasses microfilm and microfiche. Micrographics is the biggest star yet in what is known as the information and image management industry.

The micrographic industry grew out of the technology that made possible the miniaturization and registration of data on film. Ninety percent of all information in the U.S. is stored on paper, thus the capability of converting images on paper to microfilm has tremendous potential.

One study projects that revenues in the information and image management field—of which micrographics is the main contributor—will double by 1991 and triple by 1996, soaring to $6.5 billion.

A key reason for this is the emergence of the optical disk—the electronic technology that will lower the cost of information and image processing and expand the market.

Used in connection with microfilm the optical disk is the state of-the-art technology for storing and delivering information. With it, the equivalent of 20 file drawers of information can be stored on one 12-inch disc.

"Stimulated by the optical disk, information management systems will experience a rapid evolution in the next three years," writes electronics and computer industry expert Harvey Janelli in *Inform* magazine.

Finally, information automation is beginning to mature to meet our needs. Because of the boom in this industry, those familiar with the technology and with the requisite skills will be in demand.

Careers in Information Management

The American Society for Information Science divides information professionals into five categories in their brochure "Challenging Careers in Information":

Managers and Operators of Information Services and Systems

> Information Resources Managers oversee the operations of a library or information center in a company, academic institution or other organization.
>
> Database Managers coordinate and maintain the collection of information.
>
> Records Managers develop and evaluate systems to improve methods of information storage and retrieval.

Specialists Who Synthesize Information for Others

> Writers and Editors convey information clearly to specialized or general audiences.
>
> Abstractors and Indexers summarize articles and reports according to specific standards, translate from foreign languages, and provide informa-

tion as keys for assessing the content of articles, books and other documents.

On-line Search Specialists determine people's information needs, find the answers to questions and then package answers in a uniform manner, such as that used in an annotated bibliography.

Information Brokers provide information for a fee, they supply clients with a variety of products and services.

Media Specialists handle the nonprint information formats, such as TV, microforms, films and tapes.

Information Systems Analysts and Designers

Information Consultants advise clients on how to develop, organize, market, expand and improve their information systems.

Library Systems Analysts develop specifications and recommend programs for improving access to large collections in libraries. Their work can include evaluating hardware, computer programs and packaged systems.

Applications and Systems Programmers devise detailed plans for solving particular problems using computers.

Information Systems Engineers design, implement, and evaluate ways of organizing and distributing information.

Educational and Research Program Specialists

Information Studies Teachers design and conduct courses that teach others about the information process, direct research projects, and write and publish articles and books.

Education and Training Specialists develop educational materials and conduct training sessions to help people use information services and systems.

Researchers study the information process, prepare proposals for funding, and design and direct pilot projects to test applications of research results.

Marketing and Sales Specialists

Sales Representatives identify potential customers for information products and services and make sales presentations.

Marketing Directors gather data to measure, analyze, and evaluate the market for information services.

Considering such breadth, it's easy to agree with author Diane Butler's assessment. Writing about the emergence of the information industry in her book *FutureWork* she summed up: "It's impact on the job market of the near future will be nothing short of stunning."

She believes that the emergence of the industry will create more jobs in traditional categories plus new positions, "some still only hinted at as new needs become known."

Although the demand for all information specialists is expected to grow in the years ahead, none offers greater promise than that for information managers.

Information Managers

Like the engineer who prevents a flood by channeling swollen river water, the information manager works to contain the information overload that threatens to inundate most organizations. As if the challenge of managing the ever-increasing information flow weren't enough, the responsibilities of some information managers have been expanding.

Already, the information managers of some forward-thinking corporations have seen the future. Instead of thinking of the computer only as a technical device, they now see it as a corporate tool to enhance their competitiveness. Business leaders are now asking how they can use their information system to increase profits. Understanding the bottom-line value of computers, they now seek corporate information officers who understand their goals and can define ways to help achieve them.

Those who have business savvy and are able to use technology to come up with solutions, are being elevated to this corporate executive status. In these new positions, corporate information officers are part of the leadership team and therefore enjoy a boost in salary.

Now, in addition to simply using information systems to manage day-to-day operations, the CIOs show management how information resources can become an element of strategic planning. As technicians, they once concentrated on processing information rapidly; now the focus is on designing technical solutions to achieve the goals of the business. Where once they concentrated on how to handle information, they focus now on what to do with this resource.

But CIOs are just one of many information management jobs that look promising in the future. There will also be a need for technicians to operate and maintain the equipment and hardware used in the information management process. In time, work in this specialty will include a greater focus on image management technology.

Although about 94 percent of the world's information is today found on paper, most analysts agree that the use of alternative media will increase dramatically in the next decade and beyond. This includes microfilm and microfiche, which today hold about 5 percent of the world's recorded information, and electronic media, which stores about 1 percent. Electronic media include optical disk and laser technology.

In addition to operating and maintaining information equipment, information managers also create software for applications or market and sell the information. Bette Steiger, executive director of the Association for Information and Image Management, suggests that you decide first if your interests lie in equipment, the process or the content.

Information managers can be involved in processing content, operating, maintaining, or servicing equipment. They can supervise facilities that organize knowledge by specific subject areas as well as information storage and retrieval departments. They can also provide information and consultation on problems within an organization.

One of the most exciting developments in information management is the evolution of data. Once stored on paper, film, tape, and floppy and hard disc, information is now more often being stored on optical disc. A strong future would seem assured for anyone working with optical disc technologies and other new storage and retrieval devices, such as microfiche/microfilm readers, microcomputer systems, optical scanners, or optical disk workstations.

Industry will become more aware of how the information they've culled for one purpose can be put to other productive uses. The demand for those who are skilled in managing information will grow. Thus, future opportunities seem limitless for both managers and support personnel in the information centers.

Systems Engineers, Implementation Specialists, Documentation Specialists

One of the most promising future careers in information management currently goes by several titles: system integration specialists, internal communications network engineers, and designers. In each case these specialists, with a greater or lesser degree of responsibility, integrate a company's voice and data information systems.

Library Science

The field of information science is closely allied to library science. Because of the growth in the amount of information that libraries must manage, the attention once directed to books is turning to the assessment of all forms of information. Since 1980 more efforts have been put into getting information to the people who need it. In achieving this goal, these specialists are generally divided into four major career categories:

operators of information systems

managers of information systems

designers of information systems

researchers and teachers

Other job titles run the gamut. The 4,000 members of the American Society of Information Science fall into 23 different categories. These include information system specialists in medicine, chemistry, biology, energy, and the environment. Within these specialties, jobs can also be categorized into the preceding work classifications: operators, managers, designers, and researchers of information systems.

Considering the potential of the information management industry, a strong future demand for workers in any information systems area seems certain. When we consider the future forecasts that call for more leisure time for all of us, we see why the librarian's services will be needed. In fact with more free time plus the trend toward lifelong learning, libraries may become even more popular for some. For students, however, who may rely more on the computer as an information resource continual, trips to the library may decrease. To accommodate these information users, librarians of the future may spend more time organizing information students receive on consoles.

More Jobs and Careers

Some of the newest job titles reflect the integration of one or more information technologies. From the Association for Information and Image Management's report, *Information and Image Management Industry Job Descriptions*, comes this partial list of job titles that reveal what the marketplace is demanding:

Micrographics Shift Supervisor

Microfilm Laboratory Supervisor

Preservation Office Manager

Quality Assurance Technician

Rotary Camera Operator

Planetary Camera Operator

Some of the titles found in AIIM's membership list offer more clues:

Work Flow Analyst

Micrographics/Photoduplication Department Supervisor

Data/Document Preparation Clerk

Optical Data Preparation Specialist

Vice President/Information Center

Preparing for Information Careers

Because the complexity of jobs in the field varies, so do the kinds of skills, interests, and training they require. Here are some thoughts on two of the most significant positions in the information management career field.

Library Science

Most people in library science share some or all of these abilities: to communicate, to organize, to design, to analyze, and to synthesize.

As for schooling, although the proper information is taught to prepare one for the industry, college catalogs do not usually list a department of information studies. Therefore, the American Society for Information Science suggests if you attend a college or university that does not list such a department, that you major in behavioral science and minor in computer science—or vice versa.

They also suggest the core courses that usually prepare students for a career in information science:

library science

behavioral science, including psychology and sociology

communications, including journalism, technical writing, printing, radio, and television

business administration.

The American Library Association, Standing Committee on Library Education, is the best source of information on the differing levels of library and information science education. For information on undergraduate and graduate programs send a self addressed, stamped, return envelope to this group at 50 E. Huron St., Chicago, IL 60611.

More and more often these days, those who plan for the future are also are specializing in a discipline such as sociology, chemistry, business administration, computer science, or library science.

Information Management

A combination of skills is needed in information management: the ability to analyze problems and to find the means of solving them. This means that you must know application methodology plus the capabilities of various modern business technologies, including on-line systems, database/data communications systems, decision support systems, distributed data processing, and office automation.

If there's one skill that is paramount to success in the information management field, however, it's the ability to organize, according to Steiger, of the Association for Information and Image Management. She also believes, as reported in the *Washington Post*, that "one cannot argue strongly enough the importance of computer education . . . What we're talking about is computer *literacy*, not computer *expertise*."

Information Managers who become CIOs most often move up from positions in marketing, product development, or finance. Those who have worked exclusively on the technical side of information management but who want to move up to CIO, get the knowledge they need in several ways. Some return to school for a MBA degree or a computer science undergraduate degree. Others gain a broader background in business by studying such courses as accounting, marketing, and product development at night.

Further reading will provide other clues on how best to prepare for an information career that will involve innovative work that Marian, the librarian couldn't imagine.

Resources

American Library Assn., Office for Library Personnel Resources, 50 E. Huron St., Chicago, IL 60611. Free booklet available: "Library and Information Careers in the '80s" and "Graduate Library Education Programs."

American Society for Information Science, 1424 16th St., NW, Suite 404, Washington, DC 20036. Extensive research library open to public. The association also distributes a Washington Post reprint "Information Explosion Creates Variety of Jobs."

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Chapter 8

COMPUTER CAREERS

"We know what we are, but not what we may be."
—Shakespeare, 1600

"Perhaps the most exciting technological enterprise in history," is how Abraham Peled writing in *Scientific American* describes the computer revolution.

We understand why he may be right as we look at the way in only 50 years the computer has become so essential to business, industry, science—all of industrial society that depends on the flow of information. It is the engine propelling a revolution that has as yet to be adequately named or described. "Whether we call it the information age, computer revolution, electronic epoch or micromillenium, there's no doubt America and the world are in the early states of a new era." Texe and Wanda Mars sum up in their book *High Tech Careers*.

During the first phase of this revolution we saw the industrial application of computers. As we now enter the second stage machines will become easier to use and more flexible. They'll become "intellectual utilities" as accessible and useful as telephones are now.

To get an idea of where we're going in the future, we need only look at the ways computers are presently being used. Here's a partial list of what computers do now to make our lives easier:

dispense cash at banks

scan groceries and ring up the bill at the supermarkets

give wristwatches a voice; (enter the talking time piece)

program machines to return a tennis serve like John McEnroe might

automatically dial the telephone number of parents and deliver the message that their child missed school

pick up the scribbled messages on portable microelectronic note pads

automatically log the weight and speed of heavy trucks

improve security by making credit and ID cards "smart"

help whisk people from remote parking lots to the airport terminal turn numbers into computer generated images so that scientists can better understand everything from galaxies to viruses

locate the children, handicapped and unconscious people in a fire

inventory the parts from wrecked cars in a junk yard

track last year's farm crop and determine what to plant

run manufacturing and product design equipment

design new cars and planes

tell steel mill workers how much magnesium they should add to molten iron.

In the future we'll also see even more applications of computers. On the forefront is the computer industry's role in:

office automation—word processing, systems, electronic mail and file cabinets

computer-aided design and manufacture (CAD-CAM)—tools in factory and product development.

Artificial Intelligence and Expert Systems

In the decades ahead, computing will extend humanity's mental abilities. In addition to helping us do simple and routine things, the computer in the future will also assist in thinking—both analytically and by the logic of inference. "AI knowledge-based systems is where growth is versus robotics," says David Samuelson of Quest Systems.

Advances in AI are linked directly to the computer's capabilities which are increased as technology improves. Each generation of computers aims at greater compactness which increases the capacity for information. The first computers used vacuum tubes, the second relied on transistors, the third on integrated circuits. Each generation became progressively smaller than the preceding one. The vacuum tube computer took up a whole room and offered relatively little memory capacity. The transistor computer took up less space and had more capacity. The integrated circuits of the third generation of computers made it possible for the hardware to be housed in relatively close quarters; the memory capacity of these also improved substantially.

Now the fourth generation is just beginning to use large scale integrated circuits, vast memory banks expected to work at 1,000 times the speed of today's circuitry and to contain 1,000 times as much information.

Fifth generation computers will mimic human reasoning. One system being explored not only duplicates the human brain structure but also includes a degree of programmed free will. When free will is included in the program mix, it takes only a small leap of imagination to envision a solar-powered robot taking a sunbath when it senses a decline in its energy cells. Here are some more realistic examples of current AI applications:

Technicians at Digital Equipment rely on an expert system to tell them how to best connect the techno-jigsaw of elements required to install a computer.

Oil companies are looking at ways AI can help them explore for hydrocarbons.

Designers are experimenting with how products can be designed on screen and then tested by simulating real life situations before they are built. With this technology they can pretest various materials and methods and compare results.

Banks are trying to create loan officer expert systems that will analyze loan applications more swiftly and cost effectively than human counterparts.

The Inspector General's staff at the Department of Energy is bolstered by an expert systems that monitors the paperwork of contractors.

Geologists at the U.S. Department of Energy are using the *Prospector*, an expert system to pinpoint ore deposits that they've been trying to locate for over 50 years.

Physicians are being aided by *Caduceus*, which diagnoses 600 different diseases. Similarly, *Localize* is helping doctors find the locations of nervous system lesions that may cause muscle weakness. *MYCIN* diagnoses infectious diseases, then defends and explains its advice.

Among the research projects that will continue at least into the near future:

Finding improved methods and tools for cutting the cost of software and increasing its productivity.

Improving computer speed by miniaturizing the chip. *Scientific American* believes the process of miniaturization can be expected to continue at its current pace for at least the next 10 to 15 years.

Parallel processing which will increase the processing speed by providing the means for computers to perform tasks simultaneously instead of sequentially. *Scientific American* reports that IBM's YES machine is a parallel processor able to execute a simulation several hundred times faster than any uniprocessor. The magazine also describes the Gigaflop machine which will be able to execute 11 billion floating point operations per second. This means that instead of a typical supercomputer taking 15 years to calculate the mass of the proton, the Gigaflop 11 will do the job in four months.

Speeding up the retrieval time and the flexibility of storage in database systems by improving design, capacities and storage methods.

Making the computer easier, thus more natural for people to use. Developments in the works include computers that will respond to the voice and to written communication, and use sensors to track eye movement; another "user friendly" enhancement will enable the wearer of special gloves to manipulate the images on the screen. In addition, the display of information will become more sophisticated with 3D pie charts and graphs that are imaged in a wider spectrums of color.

Enhancing the computers problem-solving potential by developing new knowledge based systems.

Developing more sophisticated networks to link computers. According to *Scientific American*, within the next decade, high-speed computer networks will be available with capacities greater by three orders of magnitude than their 1970s predecessor—capacities will escalate to 45 million bits per second. "New computer-system configurations in which distant machines will provide responsive support as if they were in the same building will be possible."

Computer simulation—"As the massive computing power needed to simulate reality becomes available it will be used for all but the final stages of the design-to-production cycle. Computer modeling will accelerate evolutions from idea to product. The new insights gained could lead to totally new products or design concepts." Electronic simulation will also enable researchers to do experiments that would otherwise be impossible, like studying the possible effects of galaxies colliding.

The Automated Office

But of all the wonders the computer has bestowed on society, none will impact on more people than the applications already beginning to be found in the Office of the Future (see Chapters 1 and 6).

Thanks to the computer the nature of office work is changing; enlightened employers are beginning to see a new role for employees.

So far we've only glimpsed where we're headed. The computer has helped us automate our work, reducing the time and tedium of doing repetitive tasks. The next step will be for the computer to do our bidding. Instead of our adapting to the computer as we painstakingly type in commands in computer language, we'll need only to speak our commands. When that day comes computers will become our mechanical servants.

This change will make possible what may be the most exciting development of all time: the elevation of the human mind to the status of most valuable economic resource. It may seem that the mind already holds that title. But on looking close we note that instead of treating people like capital, many companies focus their attention on machines. Look at the maintenance contracts, preventative maintenance programs, protection procedures and the creation of special environments for machines.

Expressing these ideas in the July 1987 issue of *The Futurist*, technology consultant Samuel E. Bleecker concludes. "We must redefine our concepts to recognize that a strong mind, not a strong back rests at the root of our economic power." One of the main jobs of office workers in the future he believes will be as expert systems programmers. Expert systems are computer programs that use the collective knowledge of experts as the basis for judgments and decisions.

Bleecker thinks that more of the office worker's time in the future will be spent devising expert systems, writing the programs, and tailoring systems to the needs of the office.

Fewer employees will spend their time collecting or entering data and doing other routine work. Instead they'll be educated to understand the basic informational needs of their organization so they can manipulate electronic services and software for those answers.

The implementation of the office of the future will accelerate demand for people who are technically trained in information processing. And "the role of support people can't be overemphasized," believes Diane Butler, author of *Futurework*. When buyers are confused with complex new equipment they'll need reliable technical support to train them and software searchers to select their software.

The Ultimate Success Story

If the experts are guessing right, computers are where the job action will be for the remainder of the century and beyond. The story of the technology that now touches everyone's life began driving World War II at Britain's secret code-breaking center. With the express purpose of deciphering the Nazi code, the world's first electronic digital computer, Colossus, was built in 1943. The machines made it possible for the Allies to read the messages sent by the German high command and the war was won.

In 1946 American scientists invented a machine that could do more than break codes. It was the Electronic Numerical Integrator and Calculator (ENIAC), designed at the University of Pennsylvania.

Since then the computer has grown in function and decreased in both size and price. The history of modern chip technology began with the 1947 development of the transistor. Transistors which permitted single circuits to be mounted on boards replaced the vacuum tubes that powered ENIAC. Thus, computers became smaller and faster.

In the 1960s the number of circuits mounted on boards increased to one hundred and the price of a computer fell to less than $1 million.

In 1971 researchers further miniaturized the computer by replacing the transistors in large computers with tiny silicon chips. A silicon chip could hold thousands of tiny circuits, and had the electronic capability of 100,000 vacuum tubes. With all the information needed for a computer to function held on a chip, the computer got smaller. Then came the microprocessor which was even smaller. The cost of computers shrank to less than $100,000. In the 1980s hundreds of thousands of circuits were packed onto even smaller chips. Prices fell so low that consumers could purchase a rudimentary computer for only $100.

Computer Careers

Although it might look like it was the arrival of the computer that caused our shift from the Industrial to the Information Age, the real engine of change was the software. For without the software programs to drive them, computers are uselsss.

Right now there's a shortage of good software. That's because hardware has been developed at an unprecedented rate, opening ever increasing numbers of new possibilities that depend on software being written. But creating software is complex. Also because of continual change, software must be updated and adapted. To make it possible for the hardware to reach its potential, new high-level languages must be created to speed up the instruction-writing process.

Also, as more and more people own computers, the demand for better software will soar. So occupations involved with software design, programming and distribution will multiply. Among the numerous software jobs that look promising: software engineers and troubleshooters, systems designers, engineers, analysts and information managers, product engineers and communication specialists.

Quest Systems' David Samuelson agrees that the demand for computer software people will remain constant in the years ahead. He adds, however, that some specialization within the field will become more important in the future.

In agreement with this forecast, the U.S. Labor Department in its listing of the 20 fastest growing occupations, placed computer programmers in fourth place with an anticipated growth rate of 77 percent.

The U.S. Labor Department saw an even rosier future for computer service technicians and put their occupation in first place; a 97 percent growth rate is expected for this occupation between 1982 and 1995. Computer systems analyst made third place with an anticipated growth rate of 85 percent.

To get a sense of where we're going let's start with a look at today's computer job market. The U.S. Labor Dept. Dictionary of Occupational Titles lists dozens of job classifications which it breaks down into two big industries:

the data processing industry which is made up of business organizations that use computers;

the computer industry which manufacturers and sells hardware and software.

The Data Processing Industry

Today those working in the data processing industry enter primarily as data entry operators, equipment operators, programmers, and systems analysts.

Data processing jobs can be divided into nine categories:

hardware operators
computer operators
data processing managers
data processing specialists
data processing support people
programmers
applications programmers
scientific programmers
technology specialists

Within these categories are dozens of positions at various levels that require various skills: technicians, managers, planners, specialists, operators, assistants, clerks and librarians.

The Computer Hardware Industry

Positions in the computer industry, those who develop, build and sell computer hardware and provide services, include service technicians, marketing personnel, engineers, researchers and computer scientists.

The job titles include computer service technician, marketing representative, marketing technical support representative, computer scientist, researcher, computer engineer, chemist and chemical engineer.

Eight Top Computer Jobs For the Future

1. Computer Programmer

AI expert systems may be doing the programming in the distant future but that doesn't stop computer programming from being a good bet for the 21st century.

That's because more than any other category, programming offers the most alternatives. It is an open-ended job from which one can go almost anywhere in the field. Jobs range from applications programmers who write programs for specific tasks to systems programmers who write programs to control the operations of the computer.

The demand for these specialists is forecast to continue indefinitely. Programmers write the instructions that tell the computer what it can and can not do. Using computer language they design the software that processes words or performs accounting of other chores.

2. Computer Service Technician

The number of computer service technicians needed will double between 1978 and 1990.

These highly trained service workers install equipment, make routine adjustments and do preventative maintenance. Since the number of computers in use will increase, so also will the demand for those to keep them running or to replace them.

3. Computer Systems Analyst

The U.S. Labor Department projects that the number of systems analysts hired in 1990 will increase 120 percent as compared to those working in 1978 as more and more small businesses use computers. There will be more demand for analysis to evaluate how a computer system can best meet the needs of the organization. The analyst must know what computers can and can't do and how to make best use of their capabilities. This specialist must also be able to recommend the best computer for a task and find the bugs when programs don't work.

The position of systems analyst can also be the stepping stone to a career that's hot now and sure to get more so: systems integration manager.

4. Data Processor

Since those who use computers far outnumber those who manufacture them, most jobs are found in data processing. Jobs in data processing fall into five main categories: data entry workers, computer and peripherals equipment operators, programmers, systems analysis, and specialists.

Within each of these categories are various levels of responsibilities from clerks and assistants to managers and supervisors. Many advanced level data processing jobs involve specialized interests and abilities; these include such job billets as technical service manager, hardware planner, user liaison, documentation specialist, EDP auditor, computer security specialists and technical writers.

5. Data Processing (EDP) Manager

The need will grow for these managers who run complex computer centers. These executives with a combination of data processing experience and management skills, are responsible for the data processing within a organization. They may be involved in feasibility studies, new projects, hardware and software acquisition, budgets, hiring and firing.

6. Computer Engineer

Also known as a computer scientist or applications engineer, this expert performs a variety of tasks: research, hardware design, integrated circuit configuration, new systems testing. Some specialize in the materials used to construct computers ceramics, silicon, plastics, metal. Others have knowledge of lasers, fiber optics and electronic components.

7. CAD/CAM specialists

See the chapter on robotics for a description of job categories and requirements.

8. Knowledge Engineers/Expert Systems Programmers

Knowledge engineering, a subfield of AI, produces a type of computer system called an expert system. Expert systems are computer programs that perform at the level of the human expert, solving problems that are beyond the capability of conventional data processing. One of the major differences between expert systems and traditional programs is with their users. For instance, expert systems are now being used as consultants by doctors to diagnose disease, by geologists to locate mineral deposits, and by engineers to design large-scale integrated circuits.

Expert computer systems depend on a knowledge base of human expertise. The knowledge engineer interviews human experts and then translates that expertise into a language the computer can use. Great skill is needed. These experts must understand the technical field of the human expert they interview. Also, they must be able to choose a problem that can be adapted to the limitations of the expert system. Problems must be well defined, not too difficult and of a workable nature.

Right now knowledge engineers work on the frontiers of computer science, but as demand for this technology increases so also will the need for more of these experts. But although future prospects look good, there may be one thorn in the rosy forecast: Because of the sensitivity and skill needed to successfully engineer knowledge, the task may eventually be taken over by AI. However, if that happens the knowledge engineer's expertise will undoubtedly be used in ways as yet defined.

Other promising computer careers include the following.

Computer Detective

To keep up with one of the leading criminals of the future, society will need this new breed of professional. Computer security officers or watchdogs will police those who use data terminals to perpetrate computer crimes—electronic trespassers or "hackers." To protect their computer files and telephone lines, organizations will need people who, as Arnold Rosen writes in *Telecommunications*: "combine the technical knowledge of a programmer, the suspicion of an auditor, and the sleuthing instinct of a TV private eye."

To do the job the computer detective will need to prevent crime by building a strong security system. That will involve understanding security technology like encryption, the technique used to encode data, and software packages to control access to central mainframes.

Medical Computing

Medical computing should blossom. "There will always be a need for computer scientists who understand enough about medicine that they can model the thinking process of physicians well enough to simulate them . . ." writes David B. Nash, M.D. in *Future Practice Alternatives In Medicine*."

For more information he suggests writing to:

Steven G. Pauker, M.D.,
Division of Clinical Decision Making,
New England Medical Center,
171 Harrison Ave.
Boston, MA 02111

Edward H. Shortlife, M.D., Ph.D.
Medical Computer Science, TC-135
Stanford University Medical Center
Stanford, CA 94305

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The *Omni Future Almanac* includes these computer jobs in its list of emerging job markets and new careers:

> Office Networking Technologists—engineers, technicians, designers and ergonomic experts to supervise personnel, maintain and repair interactive computer systems.
>
> Computer Graphics Designers and Engineers—"the combination of CAD and CAMN will offer tens of thousands of job opportunities to persons trained in engineering, design and computer programming, individuals expert in all three of these skills will be in an enviable employment position."
>
> Data Bank Managers—The need "will increase dramatically." These specialists will need training in computer memory and storage systems plus "the programming of the particular business or discipline within which they work."

Education and Training

Career opportunities depend strongly on your education and training. So the first task is to evaluate your talents, abilities and interests. Once you've decided on your career goal, you'll need to find the educational program that will best put you on track. Among your choices will be vocational schools, data processing institutes, one- and two-year community college programs, bachelor degree and graduate programs at colleges and universities.

One way to divide educational institutions is by the length of their programs:

> six month to one-year courses at private schools prepare you to operate, schedule production control, clerk, technician
>
> two-year vocational school train you to be an electronics or computer technician
>
> two-year degree or association degree by a junior or community college, prepares you to work in business data processing, usually as programmers
>
> four-year colleges and universities offer you a large array of programs. Most prepare you for one of three careers: computer science, management, and information systems.

The American Federation of Information Processing Societies offers this advice in their free booklet "A Look Into Computer Careers":

- Don't judge a program by title alone. Since different programs may have similar titles, try to find out what the program prepares you for.
- Do seek information from counselors, school faculty, and those employed in the computer industry.
- Do ask if computer engineering or technology programs are accredited by the Accreditation Board for Engineer and Technology.

Major Career Education and Training Requirements

Computer Service Technician: The basic requirement for those entering this specialty is one or two years of training after high school in electronics or electrical engineering. Training is available through private and public vocational schools, community colleges and for those who sign up for military service in electronic courses. Some states offer special training programs for women and for former teachers.

For more information write to the Computer and Business Equipment Manufacturer's Assn., 311 First St., NW, Suite 500, Washington, DC 20001.

Also request information from government agencies, career counseling centers and sometimes at libraries. Because technology changes quickly, manufacturers train new technicians on the complexities of their own particular types of hardware.

Since computer brands vary, so do service procedures, thus computer service technicians tend to specialize in hardware. In addition to being able to think logically and analytically, workers in this specialty must be patient, have good vision and hearing and be independent.

Most entering the field begin with training in electronics or electrical engineering. Training options include vocational and technical schools, community and four-year colleges. Employers also train newcomers from one to two years before they are qualified.

Computer Systems Analyst: Education requirements vary but most hold four year college degrees and some go on to earn graduate degrees. Studies should be in technical, computer-oriented areas. Another route is to become a computer programmer, since programmers are routinely promoted to analyst positions. To be successful at this work you should be able to think logically do a number of tasks at one time, be detailed oriented and able to communicate effectively.

For more information on careers in this field write to the American Federation of Information Processing Societies, Inc., 1815 N Lynn St., Arlington, VA 22209.

Computer Programmer: Entry level skills can be learned by a dedicated person in a term equivalent to a full-time college semester. A two year degree earned at a community college speeds up advancement. Some hold four-year degrees in math, or computer science. Some earn a certificate of computer programming which speeds up promotions.

Since programmers tend to work in scientific or business organizations, experience in the field is helpful. What's needed to be successful in this career category is an ability to think logically and precisely, plus ingenuity to deal with abstract ideas. Most important is a high degree of patience to go through the tedious process of programming, and to find the defects or bugs in the systems.

For information on this career field write to the American Federation of Information Processing Societies, 1815 N Lynn St., Arlington, VA 22209.

Data Processor: Do you have the aptitude and personality to succeed in the data processing industry? With the variety of careers now available and that will be created in the future, it's hard to pin down precisely what these should be. However, most experts agree that having some or all of these qualities are essential:

Number one is the ability to reason logically which employers often discover through testing. Also you should be able to work quickly, accurately, to follow detailed instructions, to listen carefully, and solve problems.

Operators who become involved in programming and hardware problems, should have some community college training in data processing and management since they may be promoted to management positions.

Computer Engineer: Usually this expert holds a four-year degree in engineering with a specialty like chemical, industrial, manufacturing, mechanical, metallurgy, electronics or electrical engineering.

Resources

Two useful booklets are available from the Computer and Business Equipment Manufacturers Association, 311 First St., NW, Suite 500, Washington, DC 20001. Send $3 for each booklet ordered; D.C. residents must add 6% sales tax.

> "Computer Careers: Putting The World At Your Fingertips," helps secondary school students learn about careers in the industry.
>
> "Educational Guidelines for Service Technicians," outlines requirements to become a service technician for installing, maintaining and repairing business machines and computer systems.

For the free booklet "A Look Into Computer Careers" send a self-addressed and stamped envelope to:

American Federation of Information Processing Societies
1899 Preston White Drive
Reston, VA 22091

For additional information on careers in the computer and business equipment industry contact these sources may be helpful:

Data Processing Management Association
Education Foundation
505 Busse Highway
Park Ridge, IL 60068

The Hartford Graduate Center
Data Processing & Technical Programs
275 Windsor St.
Hartford, CT 06120

Information Department
IBM Corporation
Armonk, NY 10504

Jake Hegarty
Lanier Business Products, Inc.
1700 Chantilly Dr. NE
Atlanta, GA 30324

Arvis R. Swinney
National Graduate Services
Control Data Institute
2000 West Look South
Houston, TX 77027

Association for Computing Machinery
1133 Avenue of the Americas
New York, NY 10036

U.S. Office of Education
Division of Vocational Technical Education
Washington, DC 20202

Association of Computer Programmers & Analysts
11800 Sunrise Valley Dr. H808
Reston, VA 22091

Data Processing Management Association
505 Busse Highway
Park Ridge, IL 60068

Institute for Certification of Computer Professionals
35 East Wacker Dr.
Chicago, IL 60601

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Brockman, Dorothy, *Exploring Careers in Computer Software*, 1985, The Rosen Publishing Group, 29 East 21st St., New York, NY 10010. Best resource to help you answer the question "Is a career in computer software for me?" Includes listing of major job categories, informa-

tion on how to target yourself toward a software career beginning in high school, and thoroughly discusses computer-oriented colleges.

Carron, Peter L. Jr., *Computers: How to Break into the Field*, 1986, Liberty Publishing Co., 50 Scott Adam Rd., Cockeysville, MD 21030. Frank talk about what it takes to succeed in the industry. Excellent discussion on schools and how to get started. Includes extensive list of manuals, handbooks and other information resources.

Charniak, Eugene & McDermott, Drew, *Introduction to ARTIFICIAL Intelligence*, Addison-Wesley, Reading, MA 01867.

Evans, Christopher, *The Micro Millennium*, 1980, Viking Press, 40 W 23rd St., New York, NY 10010. Proposes several scenarios for the computer revolution with fascinating thoughts on its effects on work, health, leisure and more.

Johnson, George, *Machinery of the Mind*, 1987, Tempus Publishers, 104 Geneva Drive, Tell City, IN 47587. Thorough eyes of artificial intelligence experts gives first-hand view of the politics, obstacles, and triumphs of the emerging industry.

LaGassee, E., *The Computer Resource Guide*, 1988, Computer Insights, Box 1317, Concord, MA 01742.

Logsdon, Tom, *Computers Today and Tomorrow*, 1985, Computers Science Press, 11 Taft Ct., Rockville, MD 20850.

McCorduck, Pamela, *Machines Who Think*, 1981, W. H. Freeman & Co., 41 Madison Ave., New York, NY 10010.

Microelectronics and Computer Technology Corp, a high-tech consortium, part of American industry's response to the Japanese Fifth Generation computer.

Winkler, Connie, *The Computer Careers Handbook*, 1983, Arco Publishing, 215 Park Ave. South, New York, NY 10003. Extensive descriptions of major career slots, and educational programs. Includes information on how to evaluate schools, advice on how women, minorities and handicapped can break into the field.

Chapter 9

AEROSPACE CAREERS

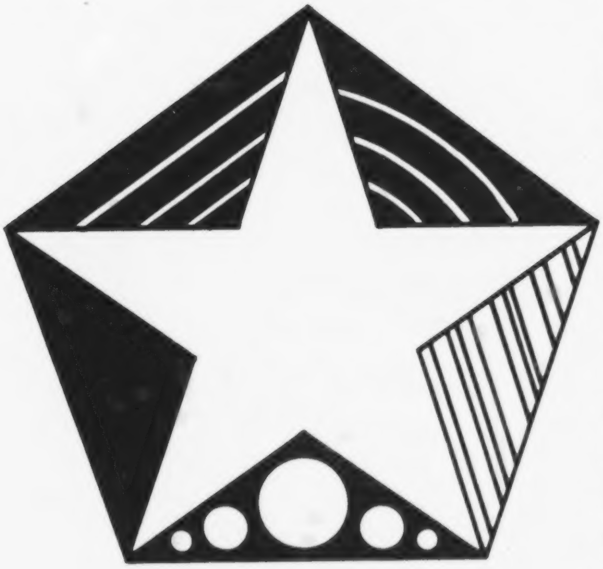
> *"The most prevalent opinion among our so confused contemporaries seems to be that tomorrow will be wonderful—that is unless it is indescribably terrible, or unless indeed there just isn't any."*
>
> —Joseph Wood Krutch, 1959

For almost a century scientists have painstakingly worked to fit the jigsaw-puzzle together. Now the star-studded picture comes into view. Communications satellites orbit. The space shuttle begins its heavenward commute. The orbiting space station ascends soon to shelter the first residents of outer space.

And down on earth, space exploration improves the quality of our lives. Among its contributions are miniaturized heart pacemakers, nonflammable foams, paints and fabrics, search and rescue beacons, solar heating units, frozen dried food, and heat resistant coatings for cookwear.

For most of us, the best-known of these to most of us are the communication satellites that relay signals from around the world to give us instant TV coverage of world events.

In addition, remote-sensing satellites take daily photos from space that increased the accuracy of our weather forecasts and help us make better use of our natural resources. Navigation satellites feed ships data on their positions. This enables captains to save time and fuel by holding to more exact courses. Other satellites now being developed will soon improve our capacity for studying earth, for producing energy, and processing materials.



We've come a long way since that day in 1957 when the Soviet Union launched Sputnik I, the first man-made satellite. Shocked, the U.S. awoke at the dawn of the Space Age. Stirred by President John F. Kennedy's challenge to win the space race, we hurried to catch up.

First came the dream, then the vehicles.

Between 1962 and 1978 we launched artificial moons and sent four spacecraft to the stars. With the development of vehicles we were on our way to the commercialization of space. In

1982 President Reagan made this goal a national policy when he shifted the focus away from the international space race, by and called for opening space to commerce.

"No one can yet comprehend the full dimensions of the possibilities that commercialization of space can generate for the service of humanity," L. B. Taylor, Jr. writes in *Commercialization of Space*. Taylor reports that experts think it's possible to create by the year 2000 a half trillion dollar space-based world economy, one that could generate 20 million jobs on earth."

The commercialization of space has begun. One of the first steps was the research in space program introduced by NASA in 1982. Called the Getaway Special, the program gives companies the opportunity to place an experiment aboard an orbiting shuttle flight. As a step in developing space expertise, companies so far have sent as payload experiments in seed germination and sprouting, fluid dynamics, metal solidification and microorganisms development.

But the most significant development in opening space to commercialization is the permanent space station now under construction. The manned space station, being built at an estimated cost of $15 billion, is slated to be in operation in 1997. From the base position 300 miles above earth, experiments will include materials processing. In an environment free of vibration, germs and gravity, products that can't be made on earth will eventually be manufactured aboard the space station. That's because materials behave differently in space. Crystal grow faster, liquids solidify more quickly, biological separations speed up, and fluid mechanics are significantly affected by the near absence of gravity.

These variations in physical process have the potential of spawning a roster of new products. Among them are these that the *Omni Future Almanac* lists: enhanced semiconductors, solar cells, new metal composites, synthetic superconductors, improved fiber optic glass, new pigments, better membranes, cell purification products and better pharmaceuticals.

Future View

To see where we're going in space, let's look at the three stages in the development of space transportation outlined by the American Institute of Aeronautics and Astronautics:

Phase #1 — Easy Access Into and Out of Space, by 1990

develop space shuttle operations, larger payloads capability, and low earth orbit space stations

launch communications and other observational satellites into higher orbits

improve astronomical observational and space rescue capabilities.

Phase 2 — Permanent Occupancy on New Earth Space, between 1995-2000

permanently occupy near-earth space

develop space manufacturing, orbital space facilities, large structures application

construct bases for further space colonies.

Phase #3 — Limited Self Sufficiency in Space, early 21st century

explore extraterrestrial materials and energy sources

establish a lunar base where raw materials can be mined

construct industrial factories and processing facilities in space

colonize space with limited urban facilities for living and working

expand an inner or lower earth orbit space transportation system.

Some experts think that rather than putting all our effort into preserving earth, we should develop space. They figure that since earth is the only planet known capable of supporting life, it should be reserved for that purpose. Industries should be placed on dead planets and these other worlds should be used in every way possible to enhance earthly life.

Space prophets like American physicist Freeman Dyson go even further. He envisions using the matter of which certain inhospitable planets are made—gas and liquid hydrogen and helium—to build replicas of Earth. Dyson suggests that a cloud of artificially produced worlds whirling around the Sun could put solar energy to better use than Earth which catches only one-billionth of that energy. Ultimately, the Earth could become independent from the sun by the time it explodes. Since we have five billion years before the sunshine stops, time is on our side.

"The coming decades will witness enormous change in how we travel in space," Omni space editors write in the *Omni Future Almanac*. What makes this change possible is the development of the world's first fully reusable spacecraft, the space shuttle. As a generic shell, the space shuttle can be shaped into various configurations to carry out specific missions. For instance, an *Omni Magazine* expert sees the possibility of the shuttle taking the form of a flying nuclear power plant, a space generator or a shuttle passenger liner.

But on a sojourn in space, just as on a vacation trip to Los Angeles, the first thing you look for upon arrival is a vehicle to use on sightseeing forays. Like the airplane that takes you to L.A., the space shuttle will only transport you to a space station. It won't necessarily also serve as a limousine once you're on location. To get around, therefore, you'll need an interplanetary U-drive spaceship or spacecab. Already scientists are designing and figuring out ways to power these space vehicles which will have to operate in gravity- and atmosphere-free environments.

When they succeed, we'll set out like explorers have for centuries. But this time instead of setting sail with a compass, we'll board space shuttles and rely on computer technology to chart our course. Like adventurers of old, we'll head for a new frontier, the one that begins where our atmosphere ends—astrospace.

Air Space Careers

Jobs in the huge aerospace industry are in four major areas:

companies that do research, develop and produce aircraft, missiles, and spacecraft;

plants that produce parts, machinery and equipment used in the manufacturing process;

NASA and the Department of Defense purchasers of industry products;

private firms that operate in the space and satellite launch field.

When people refer to the aerospace industry, they most often think of NASA. This civilian government agency established in 1958, works with a budget of about $7.5 billion a year. With that sum and a workforce of 22,000 people, the agency produces data and some hardware within its own research programs. About 90% of its funds are expended for research and development conducted by organizations outside the government with NASA overseeing the work.

Because of an overlap of programs in the military and civilian agencies, jobs in one agency are likely to be found in the other, as well. In fact many employees of one agency work jointly for the other.

NASA research activities are divided into four major programs:

Aeronautics and Space Technology identifies and demonstrates how new technology can be put to scientific, commercial and military use. Activities provide the fundamental information needed for planning future space missions and solar system exploration. Recent developments have included a new technology that could lead to vertical takeoff and landing capabilities of fixed wing aircraft and an advanced turboprop concept that increases aircraft fuel efficiency.

Space Science and Applications conducts research into the origin and evolution of the universe and investigates ways to use space systems and technologies to solve everyday problems on earth. There are six areas of focus:

Astrophysics—focuses on the study of the distant universe.

Solar System Exploration—determines the origin, evolution and present state of the solar system, compares Earth with other planets.

Communications—develops communications electronics—including communications satellites—to satisfy NASA's communications needs.

Earth Science and Applications—studies the processes that affect Earth's biological productivity and inhabitability.

Life Sciences—conducts research in space to ensure the health and well-being of space flight crews and to increase productivity in the space environment.

Microgravity Science and Applications—studies materials and their behavior in microgravity, including the potential and limitations of the microgravity environment for scientific and industrial use.

Space Flight takes on the challenge of developing the transportation and equipment necessary to give our country routine access to Space. In 1981 Space Flight engineers and scientists introduced the National Space Transportation System, the Space

> Shuttle. In addition to continuing to improve the reliability and efficiency of the Shuttle system, these specialists will work to build a manned Space Station.
>
> Space Tracking & Data Systems provides tracking, command, telemetry and data acquisition support to missions. These include earth-orbital science and applications missions, planetary missions, sounding rockets, balloons, research aircraft and all phases of the Space Shuttle operations.

These research activities further break down into 13 subgroups, each with positions for scientists, engineers and support personnel. For an in-depth discussion of the focus and employment needs of each of these subgroups see the publication *Limitless Horizons: Careers in Aerospace* published by NASA (see Resources).

In reading NASA literature and talking with just about anyone at the agency you'll come away with one dominant impression: the overwhelming need for people trained in science, mathematics and engineering.

"We're always in a crying need for technical people," says NASA's deputy director for Civil Affairs, Dr. Curtis Graves. He explains that 65–70% of NASA's work force is made up of technical people.

"Our need for technically trained people will be overwhelming by the turn of the century when we'll have aerospace planes, a space station up and running. By that time we'll also be talking about a manned mission to Mars, revisiting and colonizing the moon."

Dr. Graves points to the hard facts that cause concern: In 1986 the U.S. graduated only 21,000 engineers as compared to Japan who graduated 85,000 and the Soviet Union who produced 220,000. Only 8% of America's college graduates are in engineering; the need is many times that. As James Schefter writes in *High-Tech Careers*, "for an industry where more than one employee in every four is an engineer, keeping the pipeline filled with young, new talent is critical." In summing up the crisis he says that if we don't produce more engineers and scientists, "we're doomed as a nation." (See Chapter 1, *Futurework*.)

Obviously, the future for aerospace engineers and scientists almost out shines the stars themselves.

Aerospace Engineer

These engineers design, construct and test the bodies, engines and parts of air and spacecraft for safety, maneuverability and stability. He or she may supervise the assembly of aircraft and spacecraft and the installation of equipment.

At NASA an aerospace engineer can also hold the title of mechanical engineer, data processing program manager, civil engineer, general aviation office program manager, electrical engineer and industrial engineer. Their jobs can include:

> determining the shuttle's electrical component configuration that will support the length of the mission, propose payload experiments, and simulate the mission to be flown

managing the computer complex that processes scientific data obtained by earth-orbiting spacecraft

supervising the application of insulation on the outer surface of the shuttle's fuel tank

developing computer programs that tell the shuttle how to achieve a safe landing in the event of critical failures

managing the research of scientists and engineers involved in advance technology developments

developing new techniques for improving the quality of data collected during wind tunnel tests

analyzing the thermal protection systems for the Space Shuttle.

Usually, aerospace engineers are specialists in one of many disciplines: propulsion, aerodynamics, thermodynamics, structures, celestial mechanics, acoustics, or guidance and control.

Aerospace Scientists

As for any scientist, the role of an aerospace scientist is to observe, study and experiment in order to expand knowledge. Scientists engage in pure and basic research, applied study and research or a combination of the two. Most working at NASA develop and apply scientific methods to resolve particular issues. Work might include studies of the influence of the earth's atmosphere on human beings, the relationship of the stars and planets to earth, the properties and applications of energy sources, and alternative fuels for more energy efficient propulsion systems.

Space Insurance Broker

More than rockets and spacecraft are expected to skyrocket in the future. So also will the need for space insurance. Even though the reliability of systems will improve, the enormous cost of launches will make insurance a necessity for most companies. With the launch failure in 1986, insurance companies limited coverage or raised premiums. To help make coverage affordable, therefore, Congress is looking at the possibility of supplementing insurance costs. Whoever pays, insurance will be essential if the private sector's role in space is to continue.

Space Travel Agent

Where the trip from New York to London now takes five hours, rocket-powered craft could one day whisk passengers the same distance in 45 minutes. In time, rocket-powered flight could compete with conventional aircraft, especially when you consider that it takes less energy to put a vehicle in orbit than to fly it through the skys.

By the year 2000 the tourist traffic should begin to soar over the horizon and land on the moon. Pan American Airways is already holding 90,000 reservations for the first of these flights which could cost as much as $50,000. The cost of a trip to the moon was figured on a round trip basis, probably because no one, as yet, has asked about the cost of a one-way ticket.

Space Mortician

Remember the movie "The Loved One" in which the remains of the deceased were launched into space? It looks like the fantasy is coming true. A firm in Florida now charges $3,000 for doing exactly that. The loved one's ashes are encapsulated in a rocket nose cone and sent almost 2,000 miles above earth.

Space Mining Engineer

With a workforce or robots, the future for mining engineers in space looks promising. The industry for precious metals mined on the moon and elsewhere should grow to "gigantic proportions," Taylor believes. Among the most accessible and mineral rich destinations are the moon, Mars, Mercury and the asteroids. With the required technology now being designed, powerful electromagnetic engineers could push asteroids closer to earth for mining.

More jobs to be found in want ads of the future:

space systems analyst
communications specialist
space habitat builder
shuttle flight attendant
space hotel, restaurant manager, chef
moon base director of manufacturing
celestial mechanics scientist
ionospheric plasma physicist
planetary geologist
radio astronaut
selenologist
space university director
planetary scientists

Many occupations on earth will have their counterpart in space. Thus we can expect our future newspapers to list openings for space psychiatrists, mechanics, physicians, security personnel, teachers, botanists, police, pharmacists, real estate brokers, historians, and more.

Education and Training

One of the best ways to educate yourself about the space program is by joining one of the country's hundreds of space organizations.

In the book *Space Careers* you'll find a list of 20 space organizations and societies plus some of the hundreds of regionally based special interest groups.

Of the many at least two offer special assistance to the job seeker:

American Astronomical Society, 1816 Jefferson Pl., NW, Washington, DC 20036. Membership includes a monthly job register and operates a job center.

American Institute of Aeronautics and Astronautics, National Headquarters, 1290 Avenue of the Americas, New York, NY 10104. They offer two handbooks to members: "The AIAA Employment Workshop Handbook" and "Job Hunting: The Seven Steps to Success."

National Space Society, 912 Pennsylvanie Ave., SE, Washington, DC 20004.

Career counselors also suggest you choose an institution that is a member of the Universities Space Research Organization. This organization forms a bridge between NASA and other U.S. agencies and the organization's member universities. You can request a list of member universities by writing to the Universities Space Research Organization, The American City Buildings, Suite 311, Columbia, MD 21044.

If you're headed for a career in technology or engineering, write for the list of accredited institutions. Send your request to the Aero JET (see Resources). A list of accredited programs in engineering and engineering technology can also be found in the NASA booklet "Limitless Horizons" (see Resources).

Now for some specific information on the leading aerospace careers of the future.

Aerospace Scientists

To enter the scientific field you'll need a Bachelor's Degree with a major in mathematics or some other specific science. A Master's Degree is needed for most research work or teaching.

Aerospace Engineer

"If you wait until you have a high school diploma before you begin to think about a college degree and a career, you may be too late," warns the National Executive Committee for Guidance in their brochure "Your Career as an Aerospace Engineer" (see Resources).

To prepare for this career, combine engineering courses with other non-engineering college majors like medicine, law or business management. Also include studies in social sciences and humanities.

Usually a bachelor's degree in engineering is required to enter the field, and a master's degree is needed for some positions. Although college graduates with majors in mathematics or science may qualify for entry level jobs.

Aerospace Technician

Technicians generally attend an institute or junior college or receive training in the armed forces. There are two courses of study. One, a two year program leading to an associate degree, will prepare you to be an engineering technician. Engineering technologist requires a four year program and a bachelor of technology degree.

A career program called aeronautical engineering technology is offered by various colleges and universities. Courses focus on both enhancing analytical skills and on giving practical experience and theoretical principles. English and social studies courses should also be included.

Because of constantly new developments in the industry, you'll need to learn about new equipment and techniques and you'll need additional training throughout your professional life.

For information on careers on the technical side of aeronautics write for the brochure "Your Career in Aeronautical Engineering Technology" (see Resources).

Resources

Available from NASA, Publications XE, Washington, DC 20546:

> "Daring What Others Dream"—20-page oversized booklet describes worklife at NASA with ideas on how to join the team.
>
> "Aerospace Scientists," "Aerospace Engineers," "Aerospace Technicians," series with profiles of NASA employees. Includes descriptions of their jobs and tips on getting into NASA.
>
> "Limitless Horizons: Careers in Aerospace," 147-page manual with complete listing of NASA career positions, and details on educational requirements. Lists accredited programs in engineering and engineering technology.

Available from the Guidance Department—AERO ET, Engineers Council for Professional Development, 345 East 47th St., New York, NY 10017:

> "Your Career in Aeronautical Engineering Technology," brochure includes a do-it-yourself evaluation, information on careers and educational requirements.
>
> "Your Career as an Aerospace Engineer"—brochure includes descriptions of career positions in aerospace, and a typical curriculum.

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Sheffield, Charles & Rosin, Carol, *Space Careers*, 1984, W. M. Morrow and Co., 105 Madison Ave., New York, NY 10016. A guide for matching your skills with jobs related to space. Includes background on the U.S. space program, how to train for space careers and find a job. Special information on the role of women in the space industry and voluntary space organizations.

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Chapter 10

MEDICAL TECHNOLOGY CAREERS

> *"There is nothing like dreams to create the future. Utopia today, flesh and blood tomorrow."*
>
> —Victor Hugo, 1862

"Keep an eye on Dr. McCoy on Star Trek, some of that's really going to happen," believes University of Maryland professor Arthur T. Johnson who is also president of the Alliance for Engineering in Medicine and Biology.

From among the numerous possibilities the future holds in medical science, Dr. Johnson focuses on the one that might take even Dr. McCoy's breath away: regeneration.

"Artificial organs—including hearts—are just a stop gap; what we're really up to is unlocking the secrets of regenerating limbs and rejuvenating organs."

"We're in the basic stage of this work now," he explains. "Given enough time, the day will come when instead of working only with mechanical or electrical systems, bioengineers will put together systems to stimulate the growth of cells. These systems may involve implantation of cells or injections of hormones. What exactly, will depend on further know-how on how cells are formed in the first place."

The skeptical need only look at the track we're racing along:

> Already implanted embryo cells are enabling some diabetics to regenerate the capacities of their pancreas to produce insulin.
>
> Tissue from an adrenal gland transplanted in the brain of a woman with Parkinson's disease now makes it possible for her to control her previously rigid muscles and to walk.
>
> Following promising research on animals, scientists "predicted that human fetal tissue would eventually be implanted in brains not only to treat Parkinson's but Huntington's and Alzheimer's diseases," *Time* magazine reported (July 13, 1987).

Understanding more about the building blocks of the human body will also open the door for genetic engineering in humans. Dr. Johnson feels that one day soon bioengineers will actually design genes. But first they must learn to control what happens when they combine the basic building blocks of the gene—amino acids. When this happens, the genetic engineer will move from setting up the process controls to creating. Like an artist, he or she will be occupied painting the picture rather than preparing the canvas. Scientists are excited about this potential and what it means to mankind.

Being able "to decipher and literally write the corrections for human life will have massive implications on us and offer many opportunities, particularly for genetic counselors," believes nobel laureate molecular biologist Walter Gilbert.

"Life will no longer be a crap shoot," sums up author Jeremy Rifkin. By being able to choose the genes of our babies, life will no longer completely "bestow upon us." Instead, Rifkin suggests, we'll do the bestowing.

Although in the long run we'll be creating life and limb, in the short term we'll continue to improve on these wonders of medical technology:

- bionic implants and artificial organs
- medical devices like imaging machines that provide 3D color pictures of the human body
- lasers that make surgery safer, cheaper, virtually bloodless (see Chapter 3).

Bionic Implants

The cyborgs are coming, the cyborgs are coming! Get ready for biotechnician/woman. Already most body parts damaged beyond repair are replaced with artificial substitutes. The living being constructed from a catalog of electromechanical and biological parts, the cyborg, may be around the corner.

Barney Clark's artificial heart was only the most publicized of the bionic parts now operating in people or being tested by scientists on animals. Among these:

Cochlear (ear) implants

Delicate facia and cranial bones rebuilt from carved coral

Blood and blood vessels made of plastic

Skin made of silicone plastic and natural polymers

Visual cortices stimulated by electrical impulses that translate images enabling the blind to see Braille patterns and read five time faster

Kidneys replaced with a new technique that frees patients from the machine and allows them to carry only a small treatment kit with them anywhere

Pancreas implanted with pumps that monitor glucose and deliver supplies of insulin as needed

Hearts made of polyurethane, titanium, dacron

Lung membrane and pumps to introduce oxygen into blood and to draw carbon dioxide out during open heart surgery

Fallopian tubes that deliver a successfully fertilized egg to the uterus

Arms with tiny motors and wires that can move the limb as implanted electrodes detect nerve impulses

Elbows and hands that are totally electric. Work is being done now to improve touch sensors

Feet with plastic springs so cunningly designed that the energy created when walking can be transformed to provide lift and forward thrust

Legs with tendons and ligaments made of carbon.

Even the human skull, sanctuary of that complex organ the brain, is benefiting from the attention of bioengineers. Biochips are the means, a computer chip made of organic molecules that can be implanted in the human brain. Biologist James V. McAlear is quoted in *Omni's Future Medical Almanac* as suggesting that "by mating nervous tissues to circuit switches 100 million times faster than synapses, the implant will evolve into a superior, an omnipotent being."

Medical Equipment

"Medical technology promises to be one of the most exciting growth areas of the coming decade as new products are developed to help identify, prevent and treat disease," writes Betsy A. Collard in *The High-Tech Career Book*.

Among the devices now used in medical diagnosis, in operating rooms, and for patient care:

PET—Position Emission Tomography allows the diagnostician to actually penetrate functioning cells. Radioactive molecules injected into blood stream signal their whereabouts and how they are being assimilated into the body's organs. Ordinary X-rays show structure; PET allows look also at function.

NMR—Nuclear Magnetic Resonance, also referred to as MRI, Magnetic Resonance Imaging. By measuring the vibration of certain atoms, doctors can retrieve sharp images of internal organs and nerve tissue. Lesions that would not be visible by X-ray can now be detected.

Untrasound Machines—By converting the echoes of sound waves it images soft tissue. It's particularly useful in diagnosing heart functioning, circulation, and birth defects.

Evoked Potentials Tests—This procedure stimulates nervous system channels to see how efficiently they respond. Light patterns, clicks, or shocks test vision, hearing, or motor function.

DSR—Dynamic Spatial Reconstruction device is an enhanced descendant of the X-ray CAT scanner. It takes multiple pictures of the body and then feeds pictures into a computer presents a 3D image of a specific area to the doctor. Pictures are taken from so many angles and at such a rapid pace that doctors get a view of the body's functions that approaches animation.

(For information on how computer-assisted expert systems are helping doctors to diagnose and treat patients, see Chapter 8.)

America's ever-increasing preoccupation with health, combined with expanding life expectancy, bodes well for the medical industry. Forecasters tell us that the number of those employed in the health care industry will rise to 1.9 million by 1995. The U.S. Bureau of Labor Statistics estimates that 23% more doctors and surgeons will be needed. And if the number of doctors increases so will the need for nurses, physician assistants, and technicians. The Bureau predicts that by 1995 the demand for registered nurses and radiology technicians will rise 33% and 23% respectively.

As *U.S. News & World Report* (Dec. 23, 1985) states, "an awesome revolution in technology—and jobs—is under way." No where will it be more evident than in the medical industry where new gadgetry demands technical know-how.

Top Careers with a Future in Medicine

Biomedical Engineer

Biomedical engineers apply engineering principles and methods to solve problems in medicine and biology. The work includes developing medical and surgical instruments, designing rehabilitation devices and adapting computer technology to the health care industry.

"Although the number of biomedical engineers isn't great, the field is promising," believes Donald Strong, of the Engineering Manpower Commission of the American Association of Engineering Societies.

He points out that entry salaries are higher for these specialists—"in the neighborhood of $30,000 to 35,000' versus $28,000 for other engineers. This is because the work entails more sophisticated technology and those doing it must have an interdisciplinary education.

Biomedical engineering degrees are now offered in numerous colleges and universities. Sometimes those with electronics or mechanical engineering degrees who have done course work in biomedical engineering get into the field. (See Resources for information on free brochures.)

Biomedical Engineering Technicians

These technicians specialize in areas like bionic implants, prosthetic devices, dental tools, or various machines or electronic devices. Most in the field have earned degrees at two- to four-year schools where they learn how to operate biomedical devices. For more information see Resources.

Surgical Technician

Because of the expected growth of the health care field, the future looks bright for these operating room technicians who assist surgeons and anesthesiologists.

Requirements: Good manual dexterity to handle surgical instruments quickly, emotional stability and physical stamina are essential. Most professionals in this field train from 9 to 12 months in a vocational school, or hospital; two-year courses are also offered at some community college. See Resources for information on free brochures.

Geriatrician

In 2007 the elderly—who will make up about 15% of the population—will need physicians who understand their special needs. In the near future the role of the geriatrician will expand, particularly in the area of developing policies and programs.

Today the role of geriatricians varies: they can be gerontologists, ethicists, primary care physicians, nursing home physicians, health promoters, health analysts, or policymakers. The goal of geriatrics differs from that of medicine in general with its presumption that once the disease is cured, health is restored. Since the elderly may have numerous diseases—some of which cannot be cured—thus, the goal also includes promoting a sense of well being, and insuring the maximum comfort.

More Careers and Jobs with a Future:

Cytotechnologists

These specialized lab technicians use microscopes to examine human tissue, looking for hormonal and other pathological diseases. Because of the emphasis on detecting cancer in its early stages, demand for these specialists will remain strong.

Requirement: two years of undergraduate study and a one-year professional education program in an accredited medical school, hospital or college. For more information write to the Board of Registry, American Society of Clinical Pathologists, Box 4872, Chicago, IL 60680.

Diagnostic Medical Sonographer

In this new and rapidly growing occupation specialists operate ultrasound equipment to diagnose illness. The sonographer prepares data on the image of a specific part of the patient's body which the doctor then interprets.

Requirements: the ability to handle complex equipment and skill in working with people. You can enter the field with only a high school diploma plus one- or two-year professional training. (See Resources for information on a free brochure.)

Corporate Medical Director

Dr. David Gluck, writing in *Future Practice Alternatives in Medicine* (see Bibliography), describes this specialist as "the gatekeeper." In this role the physician can take advantage of the lack of competition from private practice and use the resources of a large organization to practice high-facility preventative medicine.

Physician Executive

This emerging career specialty is "a national phenomenon," according to David B. Nash author of *Future Practice Alternatives in Medicine*. He believes that medical administration will become a board-certifiable specialty by 1990.

In this role, the physician executive works in large health-care delivery systems to improve patient care by solving organizational problems. He or she deals with such issues as quality assurance, educational activities, and the management of data, finances, risk, and resources. Job titles vary, everything from medical director and chief of staff to chief executive officer.

Space Physician

"As we extend time in space, we'll need physicians there," observes Dr. Rufus Hessberg, executive vice president of the Aero Space Medical Association. "We've already developed the need for a clinic for the space station. How many doctors and nurses we'll need in the future depends on our colonization program. But, we'll need them. After all, just because we're in space doesn't mean we'll want less care than we'd have on earth."

Dr. Hessbert sees qualifications for a space physician as being similar to those for astronauts: The doctor practicing in a space station will need to be part of a team. He or she will have to be able to tolerate the confinement like that experienced by those on nuclear submarines or at the Antarctic.

You can get a sense of how close we are to launching a physician into space, by realizing that right now NASA is developing the standards for medical qualifications. Also, programs in aero-space medicine are part of the curriculum of at least one university—Wright State University in Dayton, Ohio—and are being offered by the U.S. Army, Navy and Air Force.

For a copy of NASA's publication, "Aviation, Space and Environmental Medicine" send $7.50 to Aero-Space Medical Association, Washington National Airport, Bldg. 3, Washington, DC 20001.

Resources

"Job Description: Certified Surgical Technologist in the O.R.," "A Profile of the Surgical Technologist,""Surgical Technology Programs,""History and Present Status of the Association of Surgical Technologists"—Association of Surgical Technologists, Inc., 8307 Shaffer Parkway, Littleton, CO 80127.

"Answers to Your Questions About an Exciting Career in Medical Technology," free brochure from the American Medical Technologists, 710 Higgins Rd., Park Ridge, IL 60068.

"Career Information: Diagnostic Medical Ultrasound," SDMS, 10300 N. Central Expressway, Bldg. 1, Suite 276, Dallas, TX 75231.

"Biomedical Engineering: A Career Guide," National Engineering Council for Guidance, c/o JETS, 1420 King St., Suite 405, Alexandria, VA 22314-2715.

"The Medical Physicist: A Scientist in Modern Medicine," "The Roles, Responsibilities, and Status of the Clinical Medical Physicist"—American Association of Physicists in Medicine, 11 East Wacker Dr., Chicago, IL 60601.

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Lambert, Mark, *Medicine in the Future*, 1986, The Brookwright Press, New York, NY.

Liebemov, J., *Medical Science and Medical Industry: The Formation of the American Pharmaceutical Industry*, Johns Hopkins University Press, Baltimore, MD 21218.

Nash, David B. M.D., *Future Practice Alternatives in Medicine*, 1987, Igaku-Shoin Medical Publishers, Inc., 1140 Avenue of the Americas, New York, NY 10036. Although intended for physicians contemplating career changes, it's a valuable resource for anyone interested in the future of healthcare delivery. Includes information on career trends with chapters on geriatrics, occupational medicine, and the role of physician executive.

Nassif, Janet Z., *Health Profession Careers in Medicine's New Technology*, 2nd edition, 1981, Arco Publishing, 215 Park Ave., South, New York, NY 10003.

Perigee, G. P., *The Fast Track Guide to the Top Jobs in New Medical Careers*, 1984, Putnam's Sons, 200 Madison Ave., New York, NY 10016.

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Soy, H. C. et al., *Medical Decision Making*, 1987, Butterworth, 80 Montual, Stoneham, MA 02180.

Swanson, Barbara, *Careers in Health Care*, 1984, Dow Jones-Irwin, Homewood, IL 60430.

Tarlow, D. M., *Medical College Admission Test Student Guide*, 1987, Pator Publishers, Box 31, Sulphur Springs, MO 63083.

Teresi, Dick and Patrik Adcroft, editor, *Omni's Future Medical Almanac*, 1987, McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020. Reports on the most advanced technologies with access guide to institutions offering futuristic medical care. Each chapter by a specialist in such fields as electric therapy, brain biochips and transplants, bionic components, lasers. Good overview of these and other disciplines.

Turner, B. S., *Medical Power and Social Knowledge*, Sage Press, 275 South Boundary Drive, Newbury Park, CA 90212.

Chapter 11

SUPERCONDUCTIVITY TECHNOLOGY CAREERS

"The only way to predict the future is to have power to shape the future."
—Eric Hoffer, 1954

Conductivity Applications

"The startling breakthrough that could change our world." This headline in *Time* magazine's May 11, 1987, cover story echoed the excitement felt around the globe about recent developments in a specialized field of science called high-temperature superconductivity.

Superconductivity is the physical state that occurs when substances are cooled to the point where they have no electrical resistance. In this state, electrical currents flow without loss of energy. By contrast, when a substance has electrical resistance, it loses energy. In power lines, for example, about 20 percent of the energy of the electricity being transmitted is lost because of resistance and the generation of heat. In computers, this resistance causes problems: computer components must be given enough space so heat can dissipate.

Superconductivity itself is not a new discovery. For several decades, scientists have known that superconductivity occurred when a certain compound was cooled to within a few degrees of absolute zero (–460 degrees F). What happened in 1987 is that scientist Paul Chu created a new material in which superconductivity can be achieved at much higher temperatures.

What's made the higher temperature possible was the discovery that an usual class of ceramic material becomes superconductors at –290 degrees F. That's still very cold, indeed. But it's warm enough to prompt scientists to use the term "high temperature" to describe the new superconductivity breakthrough.

Since Chu's breakthrough, he has reported achieving superconductivity at –54 degrees F. This warming trend heats up speculation that superconductivity at room temperature (70 degrees F) may eventually be possible. When that happens, Chu and others agree, nothing will keep new materials from being developed for industrial production.

In the meantime, with the achievement of high-temperature superconductivity comes the feasibility of more applications since the cost of reaching the state is lower. Previously, in order to cool metals to the point where superconductivity occurred at -460 degrees F expensive helium had to be used. Now, since metals need to be cooled to only -238 degrees F inexpensive nitrogen can be used instead. This means that tapping this phenomenon of physics becomes more economically feasible. Instead of using it only for such expensive applications as the medical technology of Magnetic Resonance Imaging (see Chapter 10) other applications become realistic for the first time.

The possibilities overwhelm. One expert noted that the possible applications are almost as broad as the entire field of electricity and magnetism.

In fact, "The invention will generate inventions we can't foresee today," IBM vice president for science Praveen Chaudhari was quoted as saying in *U.S. News & World Report* (May 11, 1987).

Two facts make this forecast realistic. Superconductivity not only eliminates electrical resistance but also can be used to generate very powerful magnetic fields. Someday these characteristics may create a revolution in the way we generate and transmit electricity, design and build computers and other electronic equipment, and transform our transportation systems.

Capitalizing on its properties we may use superconductivity to create fusion, to rotate machinery, to store energy, to levitate trains, and to launch space vehicles.

Here, more specifically is a future scenario, the top of news headlines in the year 2000 and beyond:

> Inexhaustible amounts of energy are now available through the use of superconductors that produce electricity through nuclear fusion. The breakthrough came as researchers were able to make an efficient reactor by using superconducting to make powerful electromagnetic coils. Only by using superconducting coils could they create a magnetic field powerful enough to contain the intense fusion reaction.
>
> Prototypes of magnetically levitated trains introduced by the Japanese in the 1980s now revolutionize transportation. The magnetism provided by superconductivity not only propels trains but also suspends then a few inches above the rails. As a result, there is no friction, travelers feel as if they're floating. These "Flying Trains" maintain speeds of 300 miles per hour and operate safely, quietly and without pollution.
>
> Transmission lines thousands of miles long join the world in a common power pool. Since superconductivity makes possible the transmission without the loss of energy, utiity costs are reduced. With increased power capacity and lower costs, electric power is now being developed in places that were once too remote and in poor countries.
>
> Superconductive electric motors propel cars at near highway speeds; with scarcely any need for recharging.
>
> Magnetic levitation now lifts heavy objects and moves them along assembly lines.
>
> Superconductive sensors in space detect the far-off heat of missile launches.
>
> Superconductive sensors sprinkled over the ocean track submarine movement.

By using electromagnetic force fields ships at sea move quietly and with no moving parts thanks to the field generated by magnets that forces sea water through pipes to propel the vessel.

Because heat is no longer a problem computers are getting smaller and smaller. The newest computer entry now fits on a single microchip.

Most significant of these is the high energy physics market which includes funding for the superconducting super colider (SSC). The promise of the SSC, the world's largest high-energy physics accelerator, is that it will create a market for superconductors. By creating a market for more than $1 billion, the SSC could "underpin an industrial infrastructure," according to *High Technology* magazine. Repeat orders over a number of years could spur production of superconducting magnets for electric power generation, transmission and storage, as well as in cryogenic refrigerators.

Even when expensive helium had to be used to create superconductivity, its dominant market was in providing the magnets used in magnetic resonance imaging (MRI). With high-temperature superconductivity and the resulting lowering of costs to produce the effect, it is estimated that the $600 milion MRI market will rise to $1.4 billion by 1990. Even though current MRI machines give doctors detailed images of body tissue, with improvements in superconductivity and the development of more powerful magnets, the images will be improved many times over.

Best of all—because cooling systems will be less expensive—as much as $30,000 per year may be saved by using cheap liquid nitrogen rather than liquid helium to cool machines. This means that more hospitals will offer them as alternates to exploratory surgery.

Other possible commercial applications for high temperature superconductivity includes magnetic shielding, infrared sensors and telecommunications. The simplest applications like magnetic shielding could appear in the shortest time. Next could come instrument applications. Further in the future will be the more complex application of high temperature superconductivity in large magnets or computing systems.

Realizing the tremendous potential impact of these and other applications depends on overcoming design constraints set by the properties of existing materials. For the moment, a realistic assessment of the future uses of high temperature superconductors awaits data on how they can be fashioned into more useable wire or pattern film configurations.

History of a Breakthrough

The road to the 1986–1987 breakthrough in high-temperature superconductors has been a long one:

In 1911 scientists find that certain metals become superconductors when cooled to temperatures within several degrees of absolute zero, -460 degrees F.

In 1973 scientists up the temperature that superconductivity occurs to -418 degrees F using an alloy of niobium and germanium.

In 1986 IBM physicists instead of using a metallic alloy use ceramic compounds and move temperature up higher to -397 degrees F.

One month later Paul Ching We Chu at the University of California at San Diego pressurizes the IBM compound to produce superconductivity at 52K or -366 degrees F.

In February 1987 Chu uses a rare earth element yttrium which he chills with nitrogen and electrifies with a current to produce superconductivity at 98K or -283 degrees F.

Since Chu's breakthrough *High Technology* magazine writes that he "recently reported superconductivity at -54 degrees F." Researchers at Wayne State University reported superconductivity-related effects at -27 degrees F.

Chu and others believe these latest experiments indicate that superconductivity at higher temperatures can be achieved. "We shouldn't let our imaginations be constrained by things we now know about. We're just not able to imagine the things you can do," IBM's William Galagher was quoted as saying by *Time* magazine (May 11, 1987).

Careers in Superconductivity

Projections give us some idea of where the industry is headed. These from *High Technology* (July 1987) forecast what five markets will be spending on superconductivity applications in 1990:

medical imaging—$350 million

high energy physics—$300 million

research and development—$100 million

electronics—$150 million

energy research—$10 million

Today, however, superconductivity emphasis is on research. Scientists are generally working in two areas: molding better conductors and designing more powerful conducting oxides.

"Although now we're in the research stage and thus need scientists with backgrounds in superconductivity, by the year 2000 there will be a shift to engineering fields," believes Robert Park, director of the American Physical Society and a professor of physics at the University of Maryland.

Park thinks the superconductivity engineers of the future will need a different emphasis in their training, "one which schools are beginning to offer now." Park refers to the courses on solid state physics and electronics which will devote much more time to superconductivity than in the past.

He elaborates that in physics the focus will be on fundamental mechanisms for superconductivity; in electronic engineering the emphasis will be on the fabrication of thin superconductor film suitable for electronic devices. In explaining the difficulty of molding current high-temperature superconductivity material into a usable form Park uses an analogy: "In effect, the engineer will have to turn a coffee cup material into a wire. That won't happen right away, it will be hard work to make ceramic malleable and useful."

Ceramic Engineers

There will be an enormous emphasis on ceramics in all sorts of departments including those dealing with metallurgy, ceramics, material fabrication. Park believes ceramic engineers will be "hot in 10 to 20 years. Their skills will be vital. In the future ceramics will play a role in material science as big as silicon plays today."

What exactly do ceramic engineers do? They develop new ceramic materials and work out the techniques and equipment for turning them into useful products. Most specialize in advanced ceramics and ceramic matrix composites used in electronic and electrical applications.

In addition to their contribution to high-temperature superconductivity, ceramic engineers in the future will be needed to develop the materials that reduce pollution and assist energy conversion and conservation.

For information on a free brochure on careers in ceramic engineering see Resources.

Electrical and Electronic Engineer

If you want to be involved in the rising impact of superconductivity on society, you'll want to consider electrical or electronic engineering as your career. Even without the new horizons opened by superconductivity, the outlook is that we'll need more and more engineers.

To get into this specialty you need strong analytical and reasoning skills, good judgment, and the ability to grasp the principles of mechanical and electrical processes. You should also like and be good at math, physics, chemistry and be able to write clearly. Hobbies that indicate your probable engineering ability is an interest in radio, automobile mechanics, model railroading, electrical experimentation. Most important, you must like working with people, be able to meet people easily and communicate your thoughts.

In choosing a college the most important question is "is it accredited in electrical or electronic engineering?" To find out consult the yearly list of accredited schools put out by the Engineers Council for Professional Development. Four-year courses give a grounding in the fundamentals, covering theory, lab methods and practical applications. Five-year courses include special courses in such fields as power, communications, computers and superconductivity.

"Pressure is mounting for a major change in engineering education for the 1990s," writes Nicholas Basta in *High Technology* Magazine. He points to a growing number of proponents for five-year undergraduate programs for engineers rather than four-year programs. Some critics feel that too many of today's engineers are merely technical specialists with universities devoting little to engineering design practice. Louis Guy, president of the American Academy of Environmental Engineers thinks that half of the engineering schools will soon offer five-year degrees.

Resources

"Careers in Ceramics," National Institute of Ceramic Engineers, 65 Ceramic Dr., Columbus, OH 43214.

"Electronics Technician: A Career for Tomorrow," Electronic Industries Association, Consumer Electronics Group, 2001 Eye St., N.W, Washington, DC 20006.

"Electronic Engineering Technology," Engineers' Council for Professional Development, 345 E. 47th St., New York, NY 10017.

"Women in Engineering," "Work and Preparation of Engineering Team Members," "Is Engineering For You?" National Engineering Council for Guidance, c/o JETS, 1420 King St., Suite 405, Alexandria, VA 22314-2715.

Other organizations that may be helpful:

American Ceramic Society
4055 North High Street
Columbus, OH 43214

Institute of Electrical & Electronic Engineers
345 E. 47th Street
New York, NY 10017

Society of Women Engineers
345 E. 47th Street
New York, NY 10017

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Backe, Richard James, editor-in-chief, *Employment Guide for Engineers & Scientists: A Practical Job Hunters' Manual*, 1984, IEEE Service Center, 445 Horsln, Piscataway, NJ 08854. This is the book for those making the transition from student to practicing engineer. Numerous experts offer advice based on personal experience.

Constance, John D., *How to Become a Professional Engineer*, 1981, McGraw-Hill, Inc., 1221 Avenue of the Americas, New York, NY 10016. Chapters include those on refresher courses, written exams, training programs, and summary of the regulation law.

Reyes, David R. and Alan M. Fischer, *The Engineering High-Tech Students' Handbook: Preparing for Careers of the Future*, 1985, Peterson's Guide, Princeton, NJ 08540. Describes the key fields, the administrative requirements, plus information on 250 colleges that offer accredited programs.

Wert, Charles, *Opportunities in Material Science & Engineering*, 1973, Universal Publishing, 800 2nd Ave., New York, NY 10017. Gives a good introduction to materials, including metallurgy, ceramics and plastics.

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Chapter 12

FINDING YOUR WAY TO TOMORROW'S CAREER

Career decisions are among the most difficult choices we make in our life span. Whether it's your first position out of school or a mid life change in career fields, the decision involves a sequence of choices and challenges. A determination to start a new job or career presents challenges. You must obtain needed education or training, arrange to pay for it, and locate a suitable position.

It is surprising, but true, that despite the problems involved, the name of the game today is often "changing your career." Many young people just out of college are finding that the training they received is not appropriate for the jobs that are available. Older people see their current fields becoming obsolete because of technological advances and they must seek new ways to earn a living. In the early Reagan years changes in political philosophy plus government spending cuts displaced thousands of government workers. For many, their skills were not directly applicable in the private sector. Advances in technology, those described in this book among them, are obsoleting countless other jobs in the private sector almost daily.

How do you approach making a decision about a new career? What do you need to know about yourself, about the new field and its demands, about how you can pull it all together? Let's look at major considerations faced by everyone considering a job or career change. They fall into three general categories: Self Knowledge, Career Research and Planning, Professional Guidance.

Self Knowledge

Matching people, their special talents, and desires to the most appropriate jobs has become highly specialized. Professional career guidance counselors, job placement specialists, and now a few professional psychologists address these problems. One thing they nearly all agree on is that finding the right job or career is highly personalized. Ask ten people you believe are happy in their work, how they got into it in the first place, and you will probably get ten different stories. Often the stories involve accidental meetings, sudden changes of personnel which put the person in the right place at the right time, or work accepted temporarily and in desperation, which developed into a lifetime interest. Their experiences are usually not replicable, nor are they of much help in guiding other seekers.

Another discovery is that those most successful in finding the very best places in the world of work—we mean careers which meet their needs and desires most completely—are those who understand themselves in depth. It is often helpful to compile on paper your own personal survey of needs, desires, and expectations, along with your own assessment of your talents, interests, and abilities. We suggest the following as a good start:

1. List your goals in life. What is most important to you? Divide this list into short and long-term goals.

2. List the subjects that interest you enough so that you have read quite a lot about them. Put a check mark (√) after any in which you have skills or have received education or training. Be sure to include any that seem "just natural" for you. For example, some people have a way with figures, or colors, or harmony, or words or whatever.

3. List your talents. What are you good at? Don't worry about overlap with your list of interests. We usually become interested in what we are naturally good at. List both esoteric and practical skills from skiing, macrame or painting watercolors, to drafting, typing, or cooking. Put a check mark (√) after any skill which is marketable whether or not you would ever want to make your living at it. Jot down as many as you can. More than one scientist has put himself through college by playing with a dance band. Secretarial, administrative, computer, and other skills can also be used to earn while preparing for a new career.

4. Assess your human relations skills and preferences. Also evaluate your communication skills. Do you like people? In large groups? Or small? Do you like to work with people? Do you like work which involves helping people? Do you prefer to work with a team, or as a loner? Can you persuade others to go along with you? Do you enjoy arguing? Winning arguments? Are you a good listener? In your ideal job, what percentage of your time would be used in working with people, with things, and with ideas?

5. Define the work environment you like best. Is it indoors, outdoors, or both? Does it involve heavy machinery? Office equipment? Do you see yourself working at a desk? In a laboratory? A production environment? Or the seas? In the air? In a moving vehicle? Or what?

6. List geographic factors, if applicable. To what other parts of the country or the world would you be willing to go in order to pursue your career objectives? Where are you currently unwilling to move?

It is also helpful to check out your personal habits of working and thinking. Clear out any potential stumbling blocks to making a progressive career move. Consider the significance of the following character traits:

1. Indecisiveness: Are you a procrastinator? Most of us are at times. Procrastination is a deadly enemy of decision making. Many people procrastinate by going over the same territory in their thinking that they have been over before—in short,

stewing around. This is usually done in order to avoid the decision to which your previous thinking led you. It may be a painful decision. You find yourself thinking "There must be some other way!" In an effort to find one, you keep repeating the same thinking. Try to catch yourself when you begin to do this. Not only is it a waste of time, but it leaves the problem unsolved. If you find yourself stewing around, you need to ask yourself "Why am I avoiding this decision? Is it because I don't like the decision to which my thinking has led me? Is it because I honestly don't have enough information?" If this is the case, you need to decide whether the needed information can be obtained without too much delay. If not, ask yourself "Can I make this decision on the basis of the available facts, plus a calculated risk?"

2. Decisiveness: For many, the only advice received about decision making from parents, counselors, or teachers is that good decisions are based on facts. "Find out all you can about a particular situation before you decide," they say. Essentially this is the scientific approach.

It is important to realize that most of the thinking in the scientific, as well as the non-scientific world is not that logical. Certainly most of the thinking which has gone on in the world has not been based on logic. Respected leaders of the Roman world made political decisions based on what their mentors gleaned from observing the configuration of the entrails of a slain chicken. The Aztecs felt that the Gods were angry with them when the earth shook or volcanos erupted. "Wrong assumptions of cause and effect," we may think smugly, but are we all that sure that we are operating on the correct assumptions for today? Students of thinking would say that it is not so much a question of right or wrong but that the Romans operated on a different system of thinking, using different basic assumptions. Roman soothsayers and their followers were *assuming* that there is a connection between the configuration of the entrails of a chicken killed on a certain day, and future events. The Romans believed a certain magic enabled soothsayers to derive wisdom that way. Today, we *assume* there is no connection. We do not believe in that kind of magic. Neither the Romans or anyone else ever proved it one way or the other.

The scientific method, which is our model for thought, grew out of the elaborate systems of logical thinking worked out by the Greeks. The scientific method adds a requirement that both the major and minor premices should be supported by much verifiable, concrete evidence before a conclusion can be drawn. Still, there is not much difference in the way we think and the way the Greeks thought some 2000 years ago. Our insistence on more concrete evidence has made the major differences in our ways of thought. In the example of the Aztecs given above, it has now been proved scientifically that volcanic eruptions and earthquakes are not caused by the anger of the Gods.

However, the vast majority of assumptions on which we base our thinking today, just as in ancient times, are not yet amenable to scientific proof. It is a shattering concept for some to realize that all chains of reasoning, whether they be scientific or not, rest on commonly accepted often unproved and unprovable basic assumptions. For a society to continue to operate, its basic assumptions do not have to be proven or provable. They do have to be commonly accepted. Many of the world's conflicts can be traced to different commonly accepted basic assumptions held by the conflicting groups. Changes in commonly accepted assumptions occur very, very slowly, but they do occur. Perhaps some citizen of the world in the year 2500 will look with patronizing superiority at the ways we have attributed causes and effects, just as we now look back on the Romans and the Aztecs.

What does all this have to do with the average man or woman confronted with career decisions? If you are considering a career change you may confront innumerable educational challenges, indifferent potential employers, and often unpleasant employment settings.

It is helpful to recognize that all the people you meet may not operate on the same thought pattern you do. When you can recognize differences, you can better control the situation.

One must also recognize that emotions influence our thinking. The emotions themselves are in part the product of our psychological and physiological conditions of the moment. As one person put it, "Don't get carried away with your hopes, your dreams—or your fears." You can become more aware of the many factors that influence decision making both internally and externally.

3. Creative imagination: Let your creative imagination loose. Spend a little time daydreaming. For example, suppose you can imagine yourself to be an ocean mining engineer. You would be organizing and directing a fleet of complex mining and research vessels—solving problems—getting results! Good! People rarely achieve anything they never dreamed about first. Use your creative imagination in this way. Allow your mind to follow through with any of the areas which interest you.

4. Idle daydreaming: Idle daydreaming, however, is often a means of escaping the tedium of today's tasks. It is not creative! It does not move you one whit closer to the object of your daydream. Use it sparingly and with awareness.

5. Laziness: Everyone needs to honestly check his or her laziness quotient once in a while. If you are considering changing careers, you can look forward to a period of extra hard work in order to accomplish your goals. Honestly appraise your willingness to work. Compute the extra time it will take to set up the new career situation while maintaining yourself in your present work. Are you willing to make the necessary sacrifice? Are you enthusiastic about it? Or are you lukewarm?

Career Research and Planning

This stage is often carried on along with your self analysis. Both research and planning may be difficult and time-consuming. If you can find the right career guidance counselor, this person may be of great help in your transition.

1. Career Information Research: As you can tell from the previous chapters, the number and kinds of jobs is expanding so fast that it is not easy to learn about some

of the newer ones. The obvious place to start is by following up on any of the relevant suggestions contained in the resources section at the end of chapters which particularly interested you. The publications and organizations listed there are starting points—that is, each can lead to further information sources.

Librarians in your community may help guide you to information within and beyond your local library. If you live near a college or university, check its library. Also, most schools have placement facilities and services. Check to see what information facilities they have that you may be able to use.

2. Make flexible plans: Careful planning is usually necessary if we are to reach any of our goals in life. This is true whether the goal is a leisurely automobile trip across the country, or a move from your present job to an entirely different type of work. As every planner has different needs, aspirations, and objectives, it is difficult to speak generally about planning. Your career plan will be similar to plans for that automobile trip. Both have a time frame and various stages and intermediate goals before the final objective. This can all be anticipated by your plans. As you move along, there may be many revisions. Some successful planners always include a contingency plan to be followed if the first one goes awry. Much of the information jotted down in your self-knowledge survey will be useful during this planning process.

3. *Seek professional help if needed:* Today's world is so fast moving and complex that it is little wonder finding a job or starting a new career is complicated and time consuming. Many persons making career changes have been helped by professional career guidance experts. A counselor can help with all three stages we have discussed above.

If you suspect that you have hidden talents or want to confirm an aptitude, counselors are trained to administer professionally devised tests and interest inventories. They also make good listeners if you wish to discuss your hopes and plans. They can provide expert advice.

Guidance counselors usually maintain a considerable collection of career information materials which they may give or loan you. They can help you find out where to obtain other needed facts. They are also familiar with training programs, and can assist you in entering the right educational preparation.

Counselors can also help with the actual job-hunting state—advising on such key areas as your resume, job application, and interview techniques.

Finding the best career guidance counselor for you can be as tricky as finding the right professional in any area of personal service. Much depends on who is available where you are located. Here are a few suggestions.

1. Check local universities' guidance and placement services. If you are taking courses there you may be eligible for their personnel services. If not, sometimes you can make other independent arrangements. They can suggest community sources which might help.

2. Check with your local board of education. A network of career guidance counselors is associated with the public schools and a call to the supervisor of guidance may help you to find an independent counselor.

3. If you feel you can reveal your intentions to ultimately move to a new career, check with the personnel department of your present employer. Some enlightened organizations assist persons who wish to transfer to new areas.

4. Check the yellow pages of your phone book under the classification "vocational guidance." There are many specialists helping people find new careers. Most offer career guidance and testing services of various kinds. Some may also be listed under "employment agencies." A word of caution is in order. Many of the independent agencies are very professional and offer very helpful services. However, occasionally there is one which requires you to sign a contract for a lengthy series of tests and advisory services which you may not need. Check with other professional guidance personnel, or write the groups cited next.

5. The National Career Development Association, a division of the American Association for Counseling and Development is located at 5999 Stevenson Ave., Alexandria, VA 22304.

6. The International Association of Counseling Services (an affiliate of AACD) lists approved counseling agencies all over the United States. Its address is 5999 Stevenson Ave., Alexandria, VA 22304.

One point which has been stressed throughout this book needs reemphasis. In order to move to the top in any of these new areas, you usually need knowledge and skills in more than one field. Some move into new areas by adding computer skills to an area of expertise they already have such as engineering, health, or statistics. Others combine three areas such as computers, medicine, and communications. In your planning, analyze how you could use your present skills in combination with new skills or knowledge which have yet to be learned. Many of the most needed combinations are unique. Study the help-wanted ad sections in the *New York Times* (its semi-annually career supplement could be most helpful) or in other leading newspaper such as the *Wall Street Journal*. Trips to the library to study the help-wanted and job openings ads in professional and trade journals may also be most revealing.

Appendix A

FUTURISTS: THE FUTURE AND YOU

The World of Tomorrow is being detailed and further expanded by futurists daily. Just since we wrote the new first chapter, new developments in creative concepts and insights have occurred. Many people are fascinated by these possibilities of the future. In effect, the futurists are painting the broad scene of the world. They are setting the stage for tomorrow's careers.

Some readers may wish to keep up to date on the latest predictions of the futurists. Others may have found it so fascinating that they are wondering how one becomes a futurist. The following list cites things you can do and activities you can join.

If You Want To Learn More About Futurism and the Latest Predictions of the Futurists:

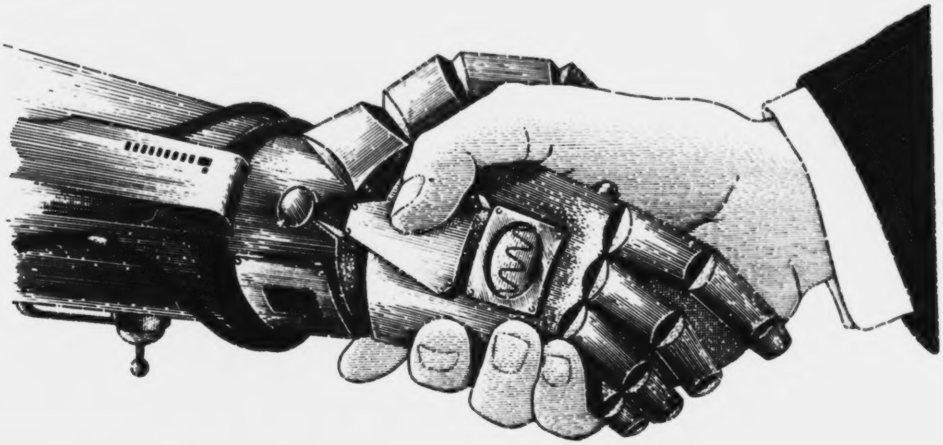
1. Join the principle futurists' organization: World Future Society, 4916 St. Elmo Avenue, Bethesda, MD 20914 (301) 656-8274. Publications available from W.F.S.:

The World Future Society The Futurist: a bimonthly journal for professional futurists and others with an interest in futures studies; $18 per year individual; $24 institutional.

Future Survey: a monthly compilation of abstracts on futures-related topics, $28 individual; $40 institutional.

Cornish, Edward, and others: *The Study of the Future*; 1977; 320 page paperback, $9.50.

The Future: A Guide to Information Sources (2nd edition, 1979). 720 page paperback; $25.00.



Feather, Frank, Editor: *Through the 80s Thinking Globally, Acting Locally*; 1980; 430-page paperback, $12.50.

Futures Research Quarterly

You may also attend WFS international meetings, held every two years, or be active in a local chapter.

2. Participate in futuristic book and film fairs. An exciting and well-run film fair is offered by Northern Virginia Community College. Check the colleges near you.

3. Take courses, seminars, and workshops on futurism. Check colleges, universities, and adult education facilities in your area.

4. Develop a self-education reading program. Good books to start with are *Future Worlds* by John Gribbin, Plenum Press, 233 Spring Street, New York, NY 10013, 1981. Also Teich, Albert H., Editor: *Technology and Man's Future*, 3rd Edition; St. Martin's Press, Inc., 175 Fifth Avenue, New York, NY 10011, 1981.

5. Subscribe to *What's Next?*, a monthly newsletter of the Congressional Clearinghouse on the Future, 555 House Annex #2, Washington, DC 20515. $15.00.

6. Be an avid reader of books and articles on futurism. Science fiction can be a good starting point. Speak to your school or community librarian about acquiring the latest books, films, and magazines on futurism.

7. Check the magazine stands for new magazines such as *Next* and *Channels*, or find these in your library's periodical room.

8. Make reference index on cards of all articles which have interested you so you can find them again or recommend them to others.

9. Visit your school, college, private or public library. Ask the librarian about using library sources such as ERIC, and *Books in Print*. Use the Medlar system for medical references.

10. Use industrial information clearinghouse, such as that of Rand and the Hudson Institute. Read their publications. The librarian can help you locate them.

If You Want To Share Your Growing Enthusiasm and Information With Others of Like Interest:

1. Form a human resources network by keeping a card file of knowledgeable people you have met who are interested in future careers and lifestyles. The network might get together for monthly luncheon or dinner meetings.

2. Start a club for futurists where interests and enthusiasms are shared. Get involved in futuristic exercises. Your club can brainstorm for ideas on this. See Appendix B for a list of futurist exercises.

3. Sponsor a book exchange program on futurist subjects such as careers, lifestyles, etc.

4. Visit other futurists both in the United States and abroad.

If You Wish To Actively Promote Public Awareness of the World of Tomorrow:

1. Schedule futurist speakers for groups to which you belong (professional, trade, religious, union, social, fraternal, etc.).

2. Have a group to which you belong sponsor an essay contest for high school students on "New and Emerging Careers in the World of Tomorrow," or "What Our World Will be Like in the Year 2083." Arrange to have the winning essay appear in the leading newspaper.

3. Investigate local school, junior college, college, and university programs to see what courses in futurism are offered. If none, or very few are offered, take the lead in seeing to it that courses are introduced. Be active in your local school system or board of education.

4. Stimulate your library's interest by donating books, pamphlets, and magazines on futurism. You can take a tax deduction for this as well as help the libraries.

5. Write up some of your ideas and suggestions on future careers and lifestyles and submit them to a local newsletter or newspaper.

6. Write letters to the editor of your local newspaper when items are discussed in the paper that have some baring on futurist careers or lifestyles.

7. At intervals, write letters to your senators and congressman calling their attention to the importance of understanding the future. Express your own interest in this area. Send them pertinent information. Ask them to send you specific information on areas relating to the future such as developments in space, solar energy, etc., including possible legislation that will make a difference in futurist activity.

Springboard Interest Areas In Which You May Wish To Become Involved:

1. For those whose IQs are 130 and above, join Mensa, a group with a strong interest in the future and which as meetings and conferences on this subject. For information write to American Mensa Ltd., 2626 East 14th St., Brooklyn, NY 11223.

2. Be active in the space program and with those groups who are supporting this thrust. There is no doubt, even though the timing may vary, that the new human frontier is in space.

3. Join a network of people who are interested in expanding their horizons. Your futurists club may already be a nucleus.

4. Read magazines on creativity or on any other futures related subject of special interest to you. Keep a file of them so they can be retrieved when needed.

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5. Attend workshops and seminars on creativity.

6. Take time to think about new ideas or inventions that could make our society more creative and productive, as well as caring and sharing.

7. Invent something that is needed and that can be nationally marketed, or devise a needed service to satisfy a recognized need.

8. Get a job in one of the "newest of the new" industries such as lasers, fiber-optics, computers, robotics, artificial intelligence, solar energy, information handling, electronic banking, etc. Or start a new small business in one of these areas.

As You Become More of An Expert in Futurism, You May:

1. Be available for futuristic talks for various organizations and schools.

2. Conduct seminars, workshops or a course on future careers and lifestyles. These meetings and workshops can be publicized at no cost in many magazines and newsletters.

3. Give short courses on futurism—start as early as grade school.

4. Act as mentor, sponsor, or advisor to others who are seeking futuristic careers.

If You Are Interested In Making Futurism Your Full-Time Career:

1. You have probably already done a large percentage of things mentioned above. Begin to further expand your network of personal contacts by speaking to leaders and officers or public relations people in some of the industries mentioned above.

2. Speak to people who are deeply involved in futurism such as Edward Cornish, Joseph Coates, Norman Feingold or persons you may have met at a national or international meeting of the World Future Society, or other associations.

3. Re-check your educational needs and qualifications as outlined in the following section.

4. See one of the new breed of career counselors who understand how fast the future is arriving, and some of the changes it will require in human behavior.

5. Armed with brainstorming ideas and concepts, prepare a resume that may open the door for a futuristic position. Check with your professional contacts or with a guidance counselor. Or you can send your resume to industries, foundations, universities, and other appropriate organizations to see what kind of a response you get. Many futurists who are working in industry are called strategic planners.

6. Read a book on, and talk to your advisors about the art of writing application letters and resumes for futuristic careers.

7. Your advisors may recommend that you write a letter to line up an interview with a working futurist, then present your resume in person during the interview.

A Word About Education and Training

At this time there are no easy answers to the question of how to become a futurist. Futurists are still small in number. Present-day futurists did not train for this field, since it has only recently emerged. They are usually highly educated and experienced in such related fields as space science, psychology, atomic energy, information science, oceanography, or economics. Their work and personal philosophical bents has forced them to think deeply about the shape of things to come.

At the present time, more than 300 colleges and universities offer courses in futures studies, many of them at the graduate level. It is now possible to earn a degree in futures studies, as such, for example, at the University of Houston. A person with this career objective might also work toward a degree in urban studies, education, sociology, or psychology. The emphasis is upon combining methods of science with human understanding developed through behavioral studies, to go on for graduate courses in futures studies.

There will be a growth of people whose main thrust will be as futurists, whether it be in the school, college, university, industry, unions, or a social agency work site. The title "futurist" may refer to a strategic planner, developer, or what have you, but futurists will help guide the destinies of their organizations to further growth and development—or to a premature demise. For some time, the people in this field will probably be those with interdisciplinary education and thrust. The future for futurists looks promising.

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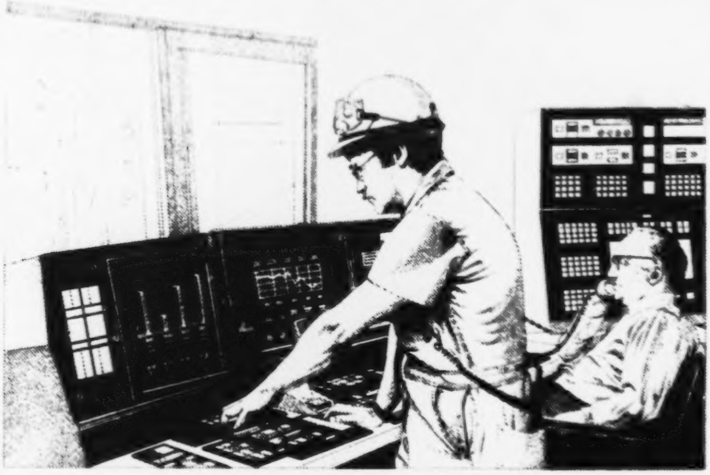
Appendix B

EMERGING CAREERS: OCCUPATIONS FOR POST-INDUSTRIAL SOCIETY

Once upon a time Ben Franklin could take his son for a walk through the streets of Philadelphia and point out all the jobs that were available. Today there are more than 30,000 different job titles.

Careers have changed from time immemorial. First, food gathering was done by women, while men did the hunting. Then came a period when most people were subsistence farmers, growing plants and animals to meet their needs for food, clothing, and shelter.

In the Middle Ages, the emerging careers were those of craftsmen and artisans. These workers made a living in the villages by serving the needs of the upper classes. The serfs continued to grow food for themselves and the overlords and to provide military service.



During the Renaissance, a whole class of artists and craftsmen, assistants and guilds developed. Business, trade, and manufacturing expanded. People worked in jobs that never existed in the preceding agricultural age.

Next, the Industrial Revolution expanded the number and types of jobs and careers. Boosted by science and technology, the expansion of jobs has intensified.

We are now entering the post-industrial period. In 1980, just 28% of the work force was in manufacturing, and it will probably be only 11% in the year 2000 and 3% in the year 2030. More people now work at McDonald's than at U.S. Steel. Businesses are adapting by diversifying their operations. Today, for example, sewing machines make up only 1% of Singer's business; the rest is in electronics.

New occupations and careers emerge all the time while others become obsolete. In comparing a past *Dictionary of Occupational Titles*, published by the U.S. Department of Labor, with the most recent one, many changes are readily observed. Numberous job titles have been added, and many hundreds of others have been deleted.

One career, for example, of short duration in the nineteenth century was that of the pony express rider, though vestiges reappear in today's courier and messenger services. The elevator

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operator, the bowling pin setter, the milkman, and hundreds of other jobs and careers have virtually disappeared, and others will follow them into oblivion. the meter-reader will soon be extinct; instead of somebody reading the gas meter at your home, gas meters can be tied in to a computer and monitored more cost effectively. In 1977, the *Dictionary* added 2,100 titles while dropping 3,500.

All of us are in occupations and careers that are in transition. For some, the job titles will remain the same while the work tasks and concepts change. For some, there will be new titles and new tasks.

An emerging career has all of the following characteristics; it is one that:

- Has become increasingly visible as a separate career area in recent years.
- Has developed from pre-existing career areas, such as medical care and personal or business services.
- Has become possible because of advances in technology or actual physical changes in our environment. For example, home computers, solar industries, satellite television, and water pollution equipment are a few of the many areas that have engendered new, emerging careers.
- Shows growth in numbers of people employed or attending emerging education and training programs.
- Requires skills and training.
- Does not appear and then disappear in a very short period of time.

Careers in the Information Industry

One of the biggest areas of emerging careers is the information industry. Today, 55% of the workers in the United States are in information industries. More people are involved in information and communication than in mining, agriculture, manufacturing, and personal services combined. Some experts are calling the changes an "information revolution." By the year 2000, 80% of the work force will be information workers.

Here are some of the emerging career areas in the information industry:

Operation of information systems. Abstractor-indexers process the intellectual content of documents for convenient retrieval. Bibliographic searchers use modern computerized information systems and data bases to identify or retrieve pertinent publications. Information brokers perform specialized information retrieval services for a fee.

Management of information systems. Information center managers supervise facilities that organize knowledge of a specific subject area.

Design of information systems. Application or systems programmers write large-scale computer programs or modify existing programs in order to solve information problems in business, science, education, and other fields.

Research and teaching. Computational linguists analyze word and language structure to determine how the computer can manipulate text for indexing, classification, abstracting, search, and retrieval. Information scientists conduct basic research on the phenomenon of information. Teachers of information science educate others in the planning, design, management, evaluation, and use of the total information process.

Consulting (or the selling of information). There has been an explosive growth of consultants of all kinds. For example, image consultants work with clients on a variety of problems such as dress, speech, and color. One of the earliest types of image consultant was the public relations consultant, who handles information and communications problems for a variety of organizations.

Information is a limitless resource. Unlike finite industrial resources such as oil, ore, and iron, there is an inexhaustible supply of knowledge, concepts, and ideas as people gain further education.

Robotics Careers

Robots are to manufacturing and mining jobs as calculators are to white-collar jobs. Each takes the monotony of repetition out of the job. Additionally, robots can do the hazardous tasks—with bottom-line effectiveness, no retirement pay, no vacations, no coffee breaks, and no strikes.

Robotics means that people will have to be trained for new skills or remain unemployed—and this includes thousands of people who formerly worked in the automobile and steel industries.

In addition to the new jobs for scientists, mechanics, and technicians that the development of robotics has created, there will be an increasing need for such workers as robots' supervisors in new, largely automated factories. But whether the development of robotics will create more jobs than robots displace is unknown at this point.

Robots are taking away thousands of blue-collar jobs. The jobs they are creating are not in these fields. The changes are of a magnitude comparable to those the Industrial Revolution created.

Overall employment in robotics is small but will grow with the increasing demand for robots. The three general types of jobs now available in the robot industry are:

Planning. Robotic engineers select jobs a robot could perform based on a thorough knowledge of the robot's capacities and of the tasks to be performed and the environment in which they are done.

Installation. Technicians install the robots and adjust them to the specific tasks involved. These people could be technical-school graduates with a special interest in robotics.

Monitoring. Supervisors check the operation of the robot on the line and keep it supplied with any needed raw materials, such as wire for a welding gun.

Ocean Industry Careers

The ocean industry is growing, with new careers ranging from catching new kinds of fish to finding ships that have sunk at sea carrying gold and other precious items. We are now cultivating the ocean the way we do the land. And researchers have discovered new kinds of sea-grown food that could have tremendous value to feeding the world's people.

Fishing and other occupations exploiting the sea are almost as old as the human race, but marine technology is making possible many exciting emerging careers, such as ocean mining, fish farming, oil prospecting, treasure hunting, and underwater archaeology.

Now let's take a closer look at some of these emerging career areas.

Ocean mining. Scientists and engineers work to solve the problem of how to retrieve and process the millions of tons of undersea minerals. Marine ecologists study how ocean mining operations could affect the ocean's environment. International sea-mining claims and law-of-the-sea treaties are new specialties for maritime lawyers.

Other areas such as off-shore drilling and deep-sea exploration require people with knowledge in more than one area, including oceanography, geology, seismology, marine engineering, and meteorology.

Underwater archaeology and treasure hunting. Until recently, no technology was available to recover artifacts from sunken ships. Now, treasure hunting using the most modern underwater techniques can be profitable, although the chances of making a fortune are small. Among the positions relating most directly to underwater exploration are project directors, professional divers, crew members, equipment handlers, sonar operators, and television camera operators.

Aquaculture. As fish supplies diminish and world population increases, scientific farming of fish and other seafoods will expand. One technique used with increasing effectiveness is polyculture, or the raising of several species together, which maximizes utilization of food and water.

Fish farming requires workers skilled in land and water management and in the care, feeding, managing, harvesting, and marketing of fish.

Exploring New Frontiers

Space, "the final frontier," has already opened up undreamed of occupations and will demand many new kinds of pioneers in the future.

Exploring space and developing its resources will require highly skilled technicians in addition to the astronauts and pilots now serving in U.S. and other space programs. Specialists in communications, computers and electronics, energy, and pharmaceuticals, for example, will work on the space shuttle or Skylab.

Eventually, as humans can remain in space for longer and longer periods of time, space programs will require miners, mechanics, ecologists, geologists, and other technicians to explore extraterrestrial materials and energy resources; to mine raw materials on lunar bases; to build and staff industrial facilities, factories, processing plants, and solar-power stations; to build space habitats and work in closed-ecology agricultural production; and to develop transportation systems connecting a growing number of space facilities.

Health Careers

Breakthroughs in genetics, bionics, cryology, laser surgery, and other medical sciences are creating exciting new career possibilities. The replacing of body organs with transplants or artificial parts represents a marriage of medical and engineering fields that has engendered such emerging careers as bionic-electronic technicians; orthotists or prosthetists, who develop surgical devices to activate or supplement weakened limbs or functions; spare-human-organs technicians; and many other previously unimagined occupations.

Electronic devices activated by voice, the blink of an eye, or a puff of breath have enabled mobility-impaired people to open doors and windows, use the telephone, etc. Closed-captioned television and movies allow the deaf to "hear."

Other new health-related careers result from changes in society, population, and lifestyles. As the population ages, for example, there will be a greater need for geriatric nurses and social workers, home health aides, nursing home counselors, stroke rehabilitation nurses, and thanatologists.

Unemployment and other economic and social ills call for mental-health professionals in new specialties such as certified alcoholism counselors, family therapists, licensed psychiatric technicians, mental-health nurses, corrective therapists, and community psychologists.

Emerging Energy Careers

After the Arab oil embargo of 1974, people began to think about energy conservation, and new career opportunities appeared:

Nuclear energy. All kinds of new jobs are emerging in the area of nuclear fission and fusion. Construction of nuclear energy plants requires thousands of skilled workers ranging from boilermakers, pipefitters, welders, and sheet metal workers to office workers, laborers, and truck drivers.

Emerging careers for operating personnel include engineers specializing in ceramics, human factors, materials, reactor safety, systems, and standards development.

Technician jobs include power-plant inspectors, nuclear fuels specialists, quality assurance specialists, instrument servicepersons, and systems reliability analysts.

Scientists needed include those specializing in health physics and the environment as well as chemists, soil and air specialists, radio chemists, and geochemists.

Fossil fuels. Though few new careers are emerging in this field, which has been automating many traditional jobs, there is a big demand for people who combine skills and knowledge in more than one area. For example, engineering geologists are crucial to coal mining, as are mineral economists, who combine knowledge of mining, petroleum, and geology with skills in economics, management science, and business.

Alternative energy. Generation of power from water, the sun, organic wastes, the wind, and geothermal resources; from cogeneration using two or more of these sources; and through energy conservation and recycling has expanded the need for workers with old-fashioned skills: electricians, pipefitters, plumbers, carpenters, and builders.

Small Business: Going Out on Your Own

From the end of World War II until the mid-1970s, small business was not looked upon favorably by the mass of young entrants into the labor force. Ten years ago, one study showed that while 27% of the parents of high-school students owned their own small business, only 3% of the children were willing to enter the same business.

This has changed. In the past five to ten years, the number of self-employed rose significantly. Small business is the key to high employment today and in the year 2000.

Twelve hundred new businesses are formed each day in the United States. In an era of bigness, more and more people are now starting to see that small is beautiful and that they can turn their interests, potential, and abilities into salable products and services. The root of American economic success has been in entrepreneurship. Today, high schools and colleges all over the United States are offering courses in small business.

Women are more involved than ever before in starting their own small businesses. Many are entering small business for self-actualization, growth, and development. Though money is still important to them, more and more people want to be able to control their lives and to believe that they are making some sort of contribution to society.

Many new small businesses are at the cutting edge of new career developments, such as communications, aids for the handicapped, and the information industry. But there are all kinds of people needs. Creative people can translate them into a successful small business.

For example, one man who earned a high salary but just couldn't get along with his supervisors decided to start his own chauffeur business because he loved to drive a car; he now has a Rolls-Royce and drives it for anyone who wants to rent it for a special event. He is busy every day and is now on the way to buying another Rolls.

What kind of economic impact does small business have? Plenty. Of all nonfarm businesses in the United States, 97% are considered "small" according to the Small Business Administration's definition. Small business accounts for nearly $7 out of every $10 in sales made by retailers and wholesalers annually. Nearly 80% of all U.S. businesses (excluding farms) employ fewer than 10 people. The small business part of the economy creates more jobs than any other; it provides, directly or indirectly, the livelihood of more than 100 million Americans—that's almost half of the current U.S. population.

Small business has been growing at the rate of 2.4% annually for the past couple of years. With more sophisticated financial planning and action by entrepreneurs, the failure rate will undoubtedly drop during the next five years.

Computers and the Changing Workplace

Computers and the information revolution are changing the workplace in many ways, and these changes affect how people work, relax, travel, think, and feel.

Recently I visited a paperless office in Washington, D.C. Most of the staff worked at home with their computers and came together only once every three or four weeks. They got their instructions for the day or week via their computers.

Computers may markedly change human behavior by altering the ways people relate to each other. Over the phone, you hear the other person's tone of voice. Face to face, you see a person's smile or anger. You also see who takes the head seat at a meeting. When people use a computer to communicate, they lack nonverbal cues since they cannot see or hear the other person. There are no cues as there are when you meet someone in person or talk to someone on the phone.

Over the next 20 years, there will be more pressure to increase job satisfaction by changing the content of jobs; today, few people seem to deeply enjoy their work and to have real psychic satisfaction. At the same time, people are likely to spend less time at work, either through shortened workweeks or through absenteeism.

While there is likely to be greater employee participation in decision-making, loyalty to one's company will probably continue to decrease. More people will change jobs or even careers more often. Training policies will be reassessed to meet an increasing need to train and retrain people. The proportion of women in the work force is likely to increase, and more of them will be career-oriented.

More people will work at home. There will probably also be more work for people in neighborhood work centers. These centers will be similar to the firms that offer a business address, an answering service, and an office to rent on an hourly or daily basis. There also can be community communication centers for sharing particularly expensive facilities, including video telephone booths, rooms for electronic meetings, etc.

While sophisticated technical skills will be needed in the twenty-first century, I believe we need to add life- and love-enhancing skills or our technology will accelerate alienation.

The concept of Win-Lose must be replaced by a Win-Win ideal. Rather than "King of the Mountain," the game we must learn now is "People on the Mountain."

When people are made to feel that their self-image and worth depend on their being on top, complex problems are created. They experience high levels of anxiety, display destructive tendencies, and show increased insensitivity to the feelings of others. They lie, cheat, hurt, maim, and kill to make it to the top. In the process, some people destroy not only their colleagues but their families and themselves.

We need to develop a special kind of sensitive balance for cooperation and individualism that allows people to live and work in harmony. People can compete in a psychologically healthy way.

We can enhance individual initiative and creativity and, at the same time, stimulate the ability or potential to work well as a team.

Appendix C
WORK AND CAREERS IN BUSINESS: 1987–2025

I. Introduction

The last decade of the 20th Century and the first quarter of the 21st Century is the time frame in which this book's readers will be active labor market participants. The pace of change in jobs and careers that provide employment opportunities may well accelerate from today's rapid tempo. The education, training, and personal requirements for these jobs will change equally as quickly. Thus, gaining a grasp of upcoming work/career trends and of future employment trends becomes necessary for today's college freshmen and sophomores, returnees to the labor force, and displaced workers. The total number of employment women will soon surpass the total number of employed men.

Farmer, laborer, clerk, professional are occupational titles that briefly elucidate the work history of the United States. Knowledge and how it transforms the tasks of farmer, laborer, clerk, and professional is the critical new ingredient of the information or post-industrial age.

Job opportunities for certain classes of "white collar" workers are changing dramatically; the number may be decreasing, also because of information technology. There is less need for middle management and clerical workers in Government and large private concerns.

Professional workers today, as they have been in the past, are almost always information workers (lawyers, teachers, engineers, accountants, librarians, psychologists, reporters, etc.). Microprocessors speed the manipulation, storage and use of numbers, words, ideas, and information. Carried another step, information that is properly manipulated, stored, and used is lessening the need for human beings as the operators of farm equipment, auto assembly lines, mining excavators, typewriters, or cash registers.

Eighty percent of workers in the year 2000 will probably be employed in the information industry or will use the tools of the information industry in heavy industry. Many, if not most of those in farming and manufacturing will be using machines made possible by the information industry.

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Some occupations and careers become obsolete but new ones are emerging all the time. Milk man, elevator operator, and bowling pin setter are three job titles that have disappeared. At the same time, new emerging careers such as information specialist, thanatologist, and divorce mediator are growing in number and influence.

The U.S. Bureau of Labor Statistics estimates that in 1984 the civilian labor force, i.e., those with jobs and those looking for jobs, totaled approximately 114 million people, or 44% of the total United States population of 237 million. BLS projections for 1995 are a total population of about 260 million with a civilian work force of about 129 million or 50%.

BLS further expects that continuing population growth will cause greater demand for workers in many industries and occupations.

From earliest times America has been the land of the entrepreneur. Our founding fathers patronized and created business, some of which are still around today.

President George Washington gave a gift of Number 6 cologne to the Marquis de Lafayette. The scent is still on sale at the nation's oldest apothecary, Caswell Massey Company, started in 1752. The Dexter Corporation was started in 1767. Located in Windsor Locks, Connecticut, it is the oldest company listed on the New York Stock Exchange. It started as a sawmill. Today, it makes products for the aerospace, biotechnology, and electronics industries. President Reagan works on his exercise treadmill and jogs on belting from the nation's oldest business, J. E. Rhoads and Sons, Inc., which was founded in Delaware in 1702.

Which of today's new business ventures will still be viable in the year 2270?

The economy of America has always been driven by entrepreneurs both in large and small concerns. Today many young people with vitality and vision are leaving king-sized corporations and making it on their own. Their thrust probably will help the United States regain its competitive clout in new areas. Entrepreneurship may provide the big push for the decades ahead.

II. Jobs and Careers. How Do They Differ? How Do They Mesh?

There is a big difference between a job and a career. A job for many workers is something they do to earn a living. They may or may not enjoy what they do from day to day. The job may provide important other benefits to the individual. The job does not, however, hold a central focus for the person's overall view of the world and its impact on the worker as a person.

A career is much more than a job. It is not only a source of financial income but also provides psychic income as well. A career is usually an important part of the person's concept of himself or herself and the world about her or him. A career means one has to keep up with new developments. It means facing changing information and many technological advances in order to function effectively. A career means more in-depth involvement than is true usually for a job. Jobs may change but a career receives much more commitment including preparation, time, and continuing education. It is expected of a person who is pursuing a career, not just a job, to continue to make contributions and life-long learning in his or her chosen field of endeavor.

We have been talking about jobs and careers. What is the main difference? The Random House Dictionary provides the following definitions. A job is "a piece of work done as part of the routine of one's occupation." It is "anything one has to do, as a task." It is "a post of employment." A career is the "progress of a person through life, as in some profession." It is "an occupation followed as one's life work."

One's life work may be followed either in industry, social services, or farming as well as in a profession. There are some people who make their careers in the insurance industry, the building trades, retail trade, health, or philanthropy. There are others who make their careers in accounting, law, or biochemistry. A significant difference between having a career as an accountant or having a job as an accountant is determined by the degree of personal commitment to educational, personal and skill growth, and tasks at work as well as identification with and contributions to accounting.

After determining their job/career choices, some people reach their career goals by obtaining training on the job. They start at an entry level job. Motivation, employer-assisted on-the-job training, and self-paid education and training enable them to obtain the required skills, education, and training to enter and progress in the career of their choice. Some careers, of course, require extended and extensive training before even an entry level job can be obtained.

For some workers a job may lead to interest and skills in a certain career. This option may not have occurred to the person in the midst of early career choice and change. For many employees their early work experiences are in a job. Later on as they advance in the world of work or gain further education and training they move on to careers.

Let's take the work history of one individual to explain the difference between a job and a career and to illustrate how jobs are a part of career development.

Career change as well as job change occurs at many life stages because of the experiences of living. Let's see how job and career experiences and planned educational steps led to changing career choices for a female baby boomer.

Undergraduate degree: A.B., psychology major

Job: Part time during undergraduate years: selling in a specialty shop and assisting store owner with his community and business activities, particularly when they require record keeping.

Graduate Degree: M.A., rehabilitation counseling

Reason for choice: Determined to continue education through doctorate in psychology; this plan offered continuing education in psychology and provided financial benefits of paid tuition by a grant and a small stipend.

Job: Continued working in the specialty shop and for the owner.

Decision Choice: Upon finishing course work for the master's degree decided that a break from formal education was needed.

Job: Moved away from college town but obtained a job in a large department store based on experience in specialty shop. Moved up to buyer. Used some of skills learned in psychology and rehabilitation counseling to train new employees. While in high school, summer jobs as a life guard and swim instructor had provided an awareness of how to teach and train.

Career Choices: Enjoyed business and started taking courses at night that ultimately led to obtaining an M.B.A.

Job assignment change at department store while studying for M.B.A.: Developed communication between the computer user staff and the buyers so that each could understand the needs of the other.

She maintained Association memberships and active involvement in local groups relating to buying, computer use in retail trade, business and professional women.

One of her professors was a highly successful business mentor who provided invaluable assistance in her career development.

Post M.B.A. Job/Career Choices: 1. Continued as buyer for department store. 2. Moved to small human relations/training concern; decision based on past experience as a trainer and working in a specialty shop. After a year she found this kind of job was not what she wanted.

Career Decision: Whether to be a consultant using her past experience and contacts or to work for someone else. Based on her personality and psychic needs, she chose to go into consulting work.

Her career remains in business particularly in those areas where her experience and contacts can be used to assist small retail companies that need professional help in going from manual systems to computerized systems.

The above example provides insight into the difference between a job and a career and how experiences can lead to career choices that originally were not considered.

III. The Resume

Before you start the job/career search, but certainly while you are conducting it, start preparing a resume. *Resume writing takes lots of time and many rewrites.* Allow yourself periods of time during which you do not look at the resume so that you can return to it with a fresh look.

The resume needs to be:

- ☐ Organized
- ☐ Coherent
- ☐ Persuasive
- ☐ Concise
- ☐ Visually pleasing

For the effective magnetic resume, you will want to:

- ☐ Organize your thoughts for maximum efficiency
- ☐ Use action verbs and nouns
- ☐ Be certain that grammar and spelling are perfect
- ☐ Inform, persuade, and appeal all at the same time
- ☐ Grab the reader's attention; then allow his or her eye to follow the flow
- ☐ Ruthlessly edit unnecessary verbiage
- ☐ Use one page; never more than two
- ☐ Do not crowd the page; use margins and white space for eye appeal

Your resume has only about 45 seconds to attract the attention of the reader.

The efficient resume has a goal: to obtain an interview, which, if skillfully handled, may result in a job or career. Write in a clear, concise manner. Focus on your career objective and the job/career you are seeking.

Resumes generally follow one of three formats. The chronological resume is the most common and most familiar to employers. It is a time ordered form with the most recent education or work experience first. It is the easiest to write. It usually is the best to use if you have had continuous employment. It is still the most widely accepted format.

The functional resume is most often used by those career candidates who wish to stress special qualifications without putting emphasis on dates. It is also used by career changers, older workers, and people leaving one work field for a very different one. Details are grouped by the skill or task they illustrate.

The combination chronological-functional resume allows stressing special skills. It also provides past employment dates. This format also helps highlight pertinent volunteer experiences in addition to salaried employment. Many personnel directors prefer the combination functional-chronological to the purely functional resume.

Two pages are usually more than enough to highlight accomplishments. A properly pruned page and a half may help establish the writer as a disciplined, organized person. Sprinkle adjectives as carefully as garlic in your cooking—a little will add spice; a lot may spoil the dish. Business-oriented nouns and action-oriented verbs will serve you well. Eliminate wordiness.

All resumes must contain name, address, telephone numbers (home and work); job/career objective; work experience; education; honors, awards, affiliations and/or community activities; references (usually available upon request).

IV. The Interview

Interviews are the final screening process. They may be conducted by one person or by a committee. Be prepared. Get as much information as you can about the organization, and if it's a conglomerate, about the company and the company within the company at which you will be interviewed. The library can provide a great deal of important information, such as the size of the company, total sales, and its business, etc. An annual report can be helpful. College placement offices have a great deal of critical job and career information about businesses and industry throughout the United States.

For most interviews you will not know in advance the exact questions you will be asked. Choose a friend to role play the interview process with you. Have fun selling yourself. Embellish a little but do not stray far from the truth. Believe in yourself. There are problem questions that can arise in an interview.

☐ What do you know about our company?

☐ Where would you like to be five years from now?

☐ Tell me about yourself.

☐ Why do you want to work for us?

☐ Why should I hire you?

☐ What did you like most and least about your present job?

☐ What two or three achievements have given you the most satisfaction?

☐ What are three of your greatest assets?

☐ What are three of your greatest limitations? When answering a question like this, couch your response in positive terms.

☐ What are your salary requirements?

☐ What was your salary in your previous position?

☐ What kind of work situation irritates you?

☐ Why did you leave your last job?

☐ How much responsibility do you like?

☐ Do you work well under pressure?

☐ Would you mind moving away from this area?

☐ When you are annoyed or angry, what do you do?

☐ What features of prior jobs have you liked or disliked?

☐ How do you evaluate your present supervisor?

☐ How do you describe yourself?

All of these questions frequently have been asked in interviews.

The interviewee is expected to have questions and to ask them. Be sure yours are legitimate ones. You won't need or want to make all of the following inquiries. Some questions may be asked safely only after the job offer. Check out answers to these questions before the interview. See whether or not the interviewer confirms the facts you have already gathered. Asterisk (*) indicates questions to be asked only if the job appears to be yours.

What are the special job duties or responsibilities of the position?

Is this a newly created position or is someone being replaced? If the latter, why did the person leave? How long was she or he on the job?

Is there a probationary period?

* Do you have to join a union after a certain period of time?

* What are the fringe benefits?

* Who will be my immediate supervisor? Where does she or he stand in the organizational picture?

* Are there parking facilities at the work site? If not, is there public transportation or the possibility of car pools?

Does the job require travel? How often?

* What are the chances for advancement on this particular job?

* Does the organization have a day care center for employees' children?

Does this organization have branches or subsidiaries? If so, how many and where are they located?

Is it possible for me to have a tour of the physical plant?

* Have there been recent employee lay-offs?

* What expenses do you pay for moving home items and family?

* Can a husband and wife both work for the company?

* If moving to a new community, do you help the spouse find a position?

* When will I begin?

What is the first challenge requiring my attention?

* Do I get a letter or contract confirming my hiring?

* Is there a profit sharing or pension plan?

V. Forced Career Choice

Once you have obtained a job or career offer, you then must choose whether or not to accept it.

The forced career choice process helps people decide whether or not to take a job offer or whether or not they should change their present job or career.

First list in no particular sequence positive factors of the job or career offer. List them all. No time limit is imposed.

Then list in no particular order negative aspects of the job or career offer. List them all. No time limit is imposed.

Assign a plus (+) or plus plus (++) to each item on your list of positive indictators.

Assign a minus (-) or minus minus (--) to each item of your list of negative indicators.

Each + or ++ item and each - or -- item may be discussed in some depth with a career counselor. After a complete discussion, if one item is decided to be of unusual importance or has a very high priority (positively or negatively), three +s or three -s may be assigned to that factor.

Should I Accept the Job or Career Offer?

Status +
Good salary ++
Psychic satisfaction ++
Some travel +
Congenial peers +
Executive office +
Chance for advancement ++
Favorable fringe benefits +
Interesting company & product +
Learn new skills +
Office near home ++
Size of company +
Total 15

High risk for failure --
Need to make an early decision -
Lots of company turnover --
Supervisor at a plateau --
Don't know any of staff -
Total 8

The odds are in favor of taking the position. Full speed ahead.

VI. Conclusion

As you read this book, remember that you are likely to engage in many jobs and several careers over your lifetime. Most jobs and careers can occur in several areas, non-profit organizations, business organizations, government, social service organizations, etc. The choice is yours. It depends upon a number of factors such as your personality, the labor market, your skills and achievements, and your family and other responsibilities.

As an optimist by conviction and temperament, I believe the forthcoming business career challenges and opportunities will be greater than ever before. As we leave the 20th Century, we will move creatively into the 21st Century.

Before we leave the field of business, let's take a look at some ideas for enterprises with a futuristic slant.

acupuncture clinic
adaptive clothing designer shop
adult day care center
ambulatory medical care center
androgynous clothing manufacturer
aquaculture farm
aquarium supplies and services
astronaut meals restaurant

bed and board hotel
bicycle & motorcycle repair services
billing services
bio-feedback health care services
bio-feedback ring and stress card services
bio-technology services
bottled water services
building material stores
burglar alarm sales and services
bus tours for college selection
business equipment sales and services

cable TV equipment manufacturer
cable TV repair services
career counseling agency
catering and fast food restaurant
cellular phone services
child and pet sitter
clearing house on new emerging careers
collection agency services
color consulting services
computer dating cards manufacturer
computer games developer
computer programming, software, and development services
computer repair and services
computer security specialist services
computer supplies store
computer telemarketing
computer training company
computerized dating services
consulting business
crisis counseling services

database management services
deep earth exploration services
deep sea search services
detective services
dialysis services
diet clinic
dispute resolution services
divorce mediation center services
drug testing services
dual career family services

education and training specialist services
educational game store
electric car services station
electronic newspaper/magazine
electronic supplies store
emerging-businesses broker
energy consultant services
environmental business assessment
ergonomic services
estate planning services
executive "head hunters" services
exotic food restaurants
experimental farmer services
express mail services

farm business consultant
fiber optics research services
fish farmer—salt water and fresh water
floating hotel
flower vending machine business
franchise services
fundraising development services
futuristic projections services

genealogy services
genetic counseling services
geriatric services
gifted students school
glass sculpture
gourmet ice cream parlor

hair growing services center
halfway house services
handicapped placement services
hazardous waste disposal services
headache care center
health food store
hearing aid services center
hearing dog services
herb farming and sales
home cleaning services
home computer store
home health care services
home and industry security services
home live-in companion service
home plant care business
home recreation services
hospice services
house rehabilitation services
housekeeping and health monitoring robot companion
human parts replacement services
hypnosis service center

image consulting business
import and export services
information broker services
instruction manual writer
international law services
international product planning services
international video dating services
invisible weaving services

large size men and women's apparel store
lawn and snow services
leisure agency services
low-cal restaurant and bakery
lunar and asteroid souvenir shop

magazines for special interest groups
magic and fun shop
management consulting services
management data analysis services
management information systems specialist services
manufacturer of equipment and supplies for swimming pools
manufacturer of ergonomic supplies and products
manufacturer of special plastics
manufacturer of sensory products
manufacturer of talking signs
marine ecologist services
media specialists services
meeting coordinator services
mid-career placement services
middle income financial planning consultants
mobile home manufacturers
mobile locksmith services
modular home builders
mood altering clinic service

nanny placement services
nationwide dial a gift business
new inventions and products assessment services
newsletters for specialized interest groups
new genetic vegetable and fruit grower
night care services for adults and children
nuclear consultant services
nursing homes and convalescent hospitals
nutrition specialist services

ocean treasure hunter
office design equipment and repair services
ombudsman service
oral history services
orthodontic supplies and services
out-placement services
outer space entrepreneur
ovum and sperm bank services
oxygen services

pain clinic services
paper clothing manufacturing
paralegal training institute
personal clothing shoppers
phonovision installation and repair services
photo inventory services
picture frame shop
polygrath services
prison services
proposal writer services
prosthetic repair shop

ransom insurance for executives
recycling services
rehabilitation service
research services
retirement hotels
robot companion for the handicapped
robot guard services
robot rental services
robot repair shop
roommate finding services

satellite saucer repair and recovery services
security system services
self help medical diagnosis supply store
seminar and workshop services
sheltered workshops
shopping services
single club services
small business broker services
solar sales and installation services
space consultant services
stock broker services
strategic planning services
street vendor
stress services center

T shirt shop
tax consultant services
telemarketing services
temporary employment services
terrorism protection consultant
training and development services
transplant registry services
truffle nursery
tutoring services

video year book publisher

walk-in health clinic services
water pollution control services
weather control services
wellness consultant services
workshops for top executives and particularly CEOs

Appendix D
EMERGING CAREER FIELDS

Abstractor-indexer
Accomodation technologist
ACP/TPF systems professional
Acquisitions expert
Acquisitions professional

Acquisitions support technician
Active solar systems equipment installer
Activist
Activities therapy coordinator
Adult day care center

Advice nurse
Advisor to top management
Advocate
Agricultural communications worker
Agricultural economist
Agriculture engineer/technologist

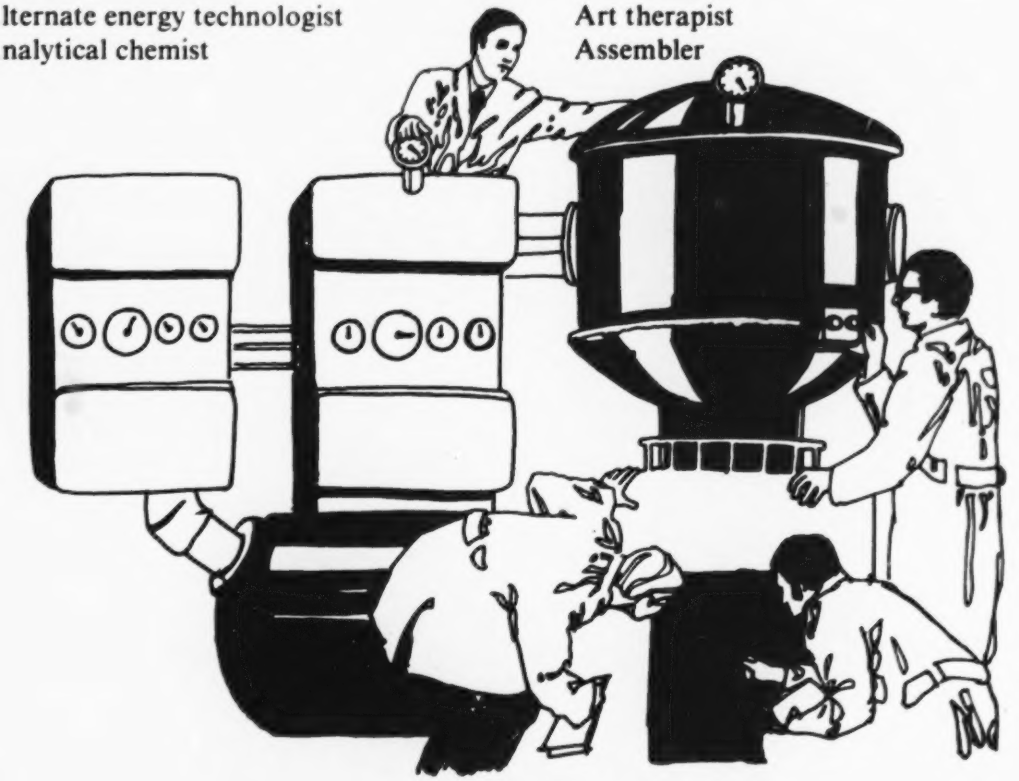
Air safety consultant
Alternate energy technologist
Analytical chemist

Analytical research chemist
Android designer
Anesthesiologist assistant

Angio technologist
Animal physiologist
Animal scientist
Antitrust litigator
Applications engineer

Applications engineer aircraft industry
Applied biologist
Applied molecular biologist
Aquaculturist
Aquatics facility manager

Arachidonic acid research assistant
Archival administrator
Arena manager
Arts manager
Art therapist
Assembler



Assessment director
Associate controller
Associate executive director
Asteroid miner

Astronaut
Astrophysicist
Audiometric technician
Audit manager health care
Automated microbiology
Avian biologist

Aviation litigation attorney
Aviation psychologist
Avionics analyst
Bank marketing executive
Bank relationships manager

Battery technician
Behavioral toxicologist
Behavioral pharmacologist
Benefits analyst
Bibliographic searcher

Biochemist
Bioethicist
Biohazard safety specialist
Bio-implantion engineer
Bio industrial sales representative

Biological quality assurance manager
Biomedical electronic technician
Biomedical engineer
Biomedical x ray repairperson
Biometric security expert

Biometrician
Bionicelectronic technician
Biostatistician
Biotechnologist
Blood donor nurse

Book rights manager
Budget analyst
Building construction schedulor
Burn rehab therapist
Business development officer

Business development specialist
Cable tv auditor

CAD/CAM designer
CAI specialist
Calibration technician
Cancer counselor

Capital market broker
Cardiac monitoring technician
Card tape convertor operator
Cardiac echo technician
Cardiopulmonary technologist

Cardiovascular perfusionist
Cardiovascular pharmacologist
CAT/CAP specialist
CAT scanner technician
Cell biologist

Cellular immunologist
Ceramic engineer
Certified alcoholism counselor
Certified financial planner
Certified medication aide

Certified midwife
Certified surgical technician
Certified yoga worker
Chemical engineer
Chemical physicist

Chemist
Chemist pharmacologist
Chief cardiopulmonary technologist
Chief information officer
Child advocate
Child development associate

Child mental health specialist
Civil environmental engineer
Claims reviewer
Clinical biochemist
Clinical dietician

Clinical engineer
Clinical intake specialist
Clinical laboratory sales representative
Clinical pharmacist
Cognitive neurophysiologist
Color consultant

Commercial planner
Commissioning engineer
Commodity manager
Communications arts technologist
Communications attorney

Communications consultant
Communications technician
Community ecologist
Community psychologist
Community residence manager

Community residence manager/handicapped adults
Compensation consultant
Compensation manager
Compliance analyst specialist
Compliance officer

Component specialist
Computational linguist
Computer consultant
Computer-consultant liaison
Computer designer

Computer graphics operator
Computer graphics specialist
Computer integrated manufacturing engineer
Computer leasing salesperson
Computer operations executive

Computer operator
Computer programmer
Computer reconstructionist, Three-dimensional
Computer salesperson
Computer systems analyst

Computer technology director
Computer type
Conference assistant
Conference planner
Configuration specialist

Consultant
Consumer advocate
Consumer credit card marketing
Contract pricing administrator
Controller

Controls/instrumentation specialist
Convention planner
Coordinator credentialing
Coordinator of government services
Coordinator of nursing resources

Coordinator recreation service
Copy editor
Corporate bond analyst
Corporate communications planner

Corporate communications writer
Corporate director of security
Corporate finance officer
Corporate image maker
Corporate information officer

Corporate lender
Corporate physician
Corporate trainer
Corrective therapist
Corrosion engineer

Cosmetic surgeon
Cost analyst
Counselor, second career planning
Counterterrorism school director
Counterterrorism school owner

Credit analyst
Credit officer
Credit operations manager
Criminal investigator
Crisis resource teacher

Cryogenic technician
Cryologist
Cryologist technician
Cultural historian
Customer service electronic Engineer

Customer service representative
Cyberneticist
Cyborg mechanic
Cyborg technician
Cytogeneticist

Contract pricing administrator
Cytogenetic lab supervisor
Cytogenetic lab technician
Cytogenetic lab trainee

Dance therapist
Data base designer
Data base engineer
Data base manager
Data base specialist

Data base typist
Data entry operator
Data processing director
Data product manager
Data security quality assurance analyst

Day care assistant
Day treatment director
Defense specialist
Dermabiologist
Design engineer

Designer/hardware software
Development director
Developmental biologist
Device engineer
Diagnostic medical sonographer

Diagnostic packaging engineer
Diagnostic prescriptive teacher
Diagnostic radiologist
Diet clinic owner
Digital design manager

Director of administrative services
Director asset management
Director audiovisual services
Director commercial consulting
Director information systems

Director inventory management
Director medical records
Director of clinical risk management
Director of communications
Director of community services

Director of exhibits
Director of facilities
Director of finance
Director of housing
Director of planning
Director of property and materials
Director quality assurance

Director research resources management
Director selection and development
Disability manager
Dock supervisor
Dog wash owner

Dosimetrist
Economic oceangrapher
EDP auditor
Educational development officer
Educational media specialist

Education specialist
EEO counselor
Electrical designer
Electrical field engineer
Electroencephalographer
Electronic engineer

Electronic filer
Electronic hydraulic underseas specialist
Electronic mail technician
Electronic microscopy
Electronics purchasing agent

Electronics specialist
Emergency medical technician
Employee benefits trust officer
Employee communications associate
Employee-leasing

Employment assistance program worker
Employment coordinator
Energy analyst
Energy and life safety systems director
Energy banker

Energy efficiency technician
Energy engineer
Energy manager
Engineering manager
Entertainment writer

Entitlement specialist
Environmental biologist
Environmental chemist
Environmental manager
Environmental planner

Environmentalist
Environmental planner
Equal employment investigator
Equestrian science trainer
Equipment engineer

Ergonomic specialist
Ethicist
Ethnic services librarian
Ethno-botanist
Ethnomusicologist

Executive recruiter
Executive salesperson
Exercise technologist
Experienced DP recruiter
Export analyst

Facilities design and construction
Facilities expansion coordinator
Facilities management
Family or divorce mediation specialist
Family therapist

Fashion editor
Fiber optic technician
Field service engineers
Finance director
Finance manager

Financial advisor
Financial engineering analyst
Financial planning
Financial programmer analyst
Financial technology consultant
Fire protection engineer

Fire technologist
Fixed income portfolio manager
Floor space manager
Food technologist
Forecaster

Forecaster/public relations specialist
Foreign exchange trader
Forensic anthropologist
Forensic scientist
Forest economist

Franchise director
Franchise owner/operator
Garden center manager
Genetic change counselor
Genetic counselor

Genetic counselor coordinator
Genetic engineering technician
Genetic mapping technician
Geneticist
Geochemist

Geotechnical engineer
Geriatric nurse
Geriatric social worker
Glassblower (Laboratory glassware)
Government procurement consultant

Grain specialist
Grants application writer
Graphoanalyst
Guided wave optics specialist
Halfway house manager

Hardware/software engineer
Head Hunter
Health care administrator
Health care executive
Health care management

Health lawyer
Health physicist
Health scientist administrator
Health services coordinator
Heat transfer specialist

Hibernation technician
High speed printer operator
HMO marketer
Holographic fiber maintenance technician
Holographic inspection specialist
Home health aide

Horticulture therapy aide
Hotline counselor
House and pet sitter
Housing rehabilitation technician
Humanfactors engineer

Human resource consultants
Human services worker
Hydraulics systems engineer
Hydrologist
Hydroponist

Ice engineer
Imaging engineer
Image management
Immigration law specialist
Immunodiagnostic salesperson

Immunologist
Indoor air quality scientist
Industrial engineer
Industrial hygiene technician
Industrial laser process technician

Industrial microbiologist
Industrial product design technologist
Information center specialist
Information center manager
Information chemist

Information engineering
Information manager
Information services director
Information support analyst
Inhalation therapist

Insect toxicologist
Instructional designer
Instrumentation engineer
Intellectual property attorney
Interest-rate swapper

Internal consultant
International contracts and pricing specialist
International controller
International data systems specialist
International director of sales

International franchise manager
International management
International marketing manager
International marketing person
International product manager

International sales manager
International systems director
International tax accountant
Interstate treasury manager
Invertebrate Biochemist

Investment Manager
Investment research specialist
Investor relations
Issues manager
Job coach

Job developer
Kenesthiolologist
Labor analyst
Labor force analyst
Labor development executive
Laser dentist

Laser surgeon
Latin American specialist
Lead programmer
Leisure counselor
Leveraged buyouts worker

Licensed psychiatric technician
Lodging Executive
Logistics engineer
Logistics managers
Loss control manager

Loss prevention area manager
Maintainability engineer
Maintenance supervisor
Mall manager
Management and public policy professional

Management engineer
Management information services consulting
Management science professional
Manager of benefits

Manager budget cost analysis
Manager diagnostic regulatory affairs
Manager distribution systems and control
Manager export business development
Manager license development

Manager new products
Manager quality management
Manager sales and revenue analyst
Manuscript editor
Marina manager

Marine Geologist
Marine historian
Market development specialist
Market export administrator
Marketing communicator

Marketing Director
Marketing engineer
Marketing manager
Marketing researcher and forecaster
Massage therapist

Materials manager
Materials flow specialist
Materials utilization technician
Mechanical engineer
Media consultant
Medical correspondent

Media specialist
Medical anthropologist
Medical ethicist
Medical records administrator
Medical research subject

Meeting and convention administrator
Meeting planner
Mental health counselor
Mental health nurse
Microbiological researcher

Merger analyst
Microbiologist
Microcomputer support specialist
Microform technologist
Micrographics
Microprocesser technologist

Microsurgeon
Microsystems Analyst
Milieu supervisors
Mineral economist
Mold engineer

Molecular biologist
Molecular geneticist
Molecular psychologist
Money desk manager
Monoclonal antibody technician

Mortgage broker
Mortgage loan correspondent
Mud engineer
Multinational calling officer
Music therapist

Naprapath
National accounts lender
National credit specialist
National sales manager
National sales and service manager

Natural design engineer
Negligence attorney
Neobiologist
Network Analyst
Network surveillance engineer

Neuroanatomist
Neurobiologist
Neurochemist
Neuropharmacologist
Neuroscientist

Neutrino astronomist
New food inventor
New frontier director
New funds coordinator
New media research analyst

Nuclear fuel broker
Nuclear fuels specialist
Nuclear instrument service person
Nuclear medical technologist
Nuclear medicine sales representative
Nuclear power plant operator

Nuclear quality assessment inspector
Nuclear quality assurance inspector
Nuclear reactor manager
Nuclear reactor operator
Nuclear reactor technician

Nuclear specialist
Nuclear waste manager
Nursing home counselor
Nurse midwife
Ocean colonist

Ocean engineer
Ocean farmer
Oceanic hotel manager
Oceanographer
Ombudsman

Operations research & systems management specialist
Operations statistician
Operator, multi-language capacity
Optical engineer
Orthotist/prosthetist
Ornamental horticulturist

Out of core fuel manager
Outplacement professional
Packaging engineer
Paleomagnetician
Paraprofessional - (Many fields such as law, social case work, dentistry, medicine, teaching, and veterinary medicine)

Paramedic
Pediatric nurse practitioner
Pension consultant
Pension specialist
Peptide chemist

Peripheral equipment operator
Personal financial planner
Personal issues manager
Petroleum engineer
Pest management

Pharmakinetaicist
Physical fitness director
Physical oceanographer

Physical security technician
Physician executive
Physician's assistant
Physicist
Pipe fitter

Planetary geologist
Planetary health officer
Planetary engineer
Planetary scientist
Planning manager

Planning program manager (Government)
Plant biochemist
Plant biologist
Plant biotechnologist
Plant ecologist

Plant geneticist
Plant pathologist
Plant physiologist
Plant therapist
Plastics engineer

Plate tectonics technician
Plumber
Podiatric assistant
Police psychologist
Policy analyst

Policy scientist
Political analyst
Political consultant
Political economist
Polygraph examiner

Polymer scientist
Pomotologist
Population ecologist
Portfolio manager
Preservation specialist

Pricing analyst
Pricing specialist
Procedural writer
Process development chemist
Process engineer
Process pumper

Procurement professional
Procurement specialist
Production artist
Production control specialist
Production engineer

Product planning executive
Professional electronics file analyst
Professional ethicist
Professional farm manager
Professional hunter

Programmer
Program analyst
Program control specialist
Program manager
Program planner

Project and task managers
Project engineer/manager
Project leader
Psychobiological clinician
Psychobiologist

Psychogeneticist
Psychometrist
Psycho-neurolimmunologist
Public affairs psychologist
Public historian

Public interest scientist
Public relations engineer
Public relations specialist
Public safety communication operator
Publication production technologist
Purchase director

Quality assurance chemist
Quality assurance manager
Quality assurance nurse
Quality control executive
Quantitive risk assessment analyst

Race horse breeder
Radiation physicist
Radiologist
Radiation ecologist
Radiation physicist

Radio astronaut
Radio chemist
Radiographer
Range animal nutritionist
Range manager

Real estate acquisition assistant
Real estate manager
Reclamation technologist
Reconstructive surgeon
Records manager

Recreation aide
Recreation manager
Recreation specialist (Theme parks)
Recreation specialist (Mentally ill, retarded or in prisons)
Recruitment officer

Regional recruiting administrator
Registered dietician
Regulatory affairs manager
Regulatory engineer
Regulatory specialist

Rehabilitation engineer
Rehabilitation job trainer
Relationship manager
Reliability engineer
Reliability specialist

Relocation counselor
Remote sensing equipment interpreter
Research engineer
Research manager
Research microbiologist

Research scientist
Research toxicologist
Reservoir engineer
Resource teacher
Respiratory therapist

Restaurant/food consultant
Retirement counselor
Review coordinator
Risk arbitrage analyst
Risk assessment assistant

Risk management administrator
Risk manager
Robotician applications specialist
Robotician philosopher
Robotics engineer

Robot attendant
Robot engineer
Robot programmer
Robot psychologist
Robot salesperson

Robot technician
Roughneck
Safety specialist
Sales engineer
Sanitarian

Satellite communication engineer
School nurse practitioner
School sociologist
Scientific data coordinator
Scientific linguist

Scientific reviewer
Seafood chemist
Securities law specialist
Security consultant
Security engineer

Security examiner
Security manager
Security sales
Security specialist
Security technician

Seismologist
Selenologist
Seminar leader
Seminar-workshop coordinator
Senior capacity planning analyst

Senior contract administrator
Senior data security specialist
Senior EDP auditor
Senior financial analyst
Senior marketing research analyst
Senior structural engineer

Senior system analyst
Senior tax specialist
Senior technician
Senior trader
Service technician

Senior trader
Sex therapist
Shopping center leasing agent
Shopping center manager
Shrimp farmer

Shyness counselor
Silicon product technician
Site acquisitions analyst
Social director
Sociobiologist

Sociolinguist
Software engineer
Software product development
Software support analyst
Software systems analyst

Software systems engineer
Software systems programmer
Soil physicist
Solar energy modular assembly
Solar energy research scientist

Solar energy systems designer
Solar energy technician
Solar ray technician
Solar wind technician
Space attorney

Space botanist
Space colonist
Space mechanic
Space mortician
Space pharmacist
Space physicist

Space psychologist
Space security control officer
Spacecraft controller
Spare human organs technician
Special accounts analyst
Special events marketer

Specification writer
Speech and language pathologist
Speech writer
Sports law specialist
Sports medicine expert

Sports psychologist
Spread spectrum specialist
Strategic planner
Strategy consultant
Stress claims specialist

Stripping operator
Stroke Rehabilitation nurse
Structured protein chemist
Submarine noise evaluation
Supervisor litigation support

Surrogate therapist
Surveillance engineer
Survey processor
Synthetic materials handler
Systems analyst

Systems analyst/designer
Systems architect
Systems planning engineer
Systems programmer
System support specialist

Tape librarian
Tax compliance manager
Teacher, information studies
Technical buyer
Technical planner

Technical service representative
Technical service scientist
Technical education sales person
Technical forecasting specialist
Technical information manager

Technical information specialist
Technical recruiter
Technical service manager
Technical service specialist
Technical specialist
Technical writer or editor

Tectonic statistician
Telecommunications analyst
Telecommunications manager
Telecommunications marketing director
Telemarketing specialist

Telemetry nurse
Telephone research interviewer
Telephone services sales representative
Teleprocess engineer
Temping worker

Teratology technician
Terrorism consultant
Test engineer
Thanatologist
Thessaurus designer

Theological consultant
Therapeutic recreation technician
Thermal engineer
Thrift analyst
Ticket processor

Tissue culture technician
Topiatrist
Toxicologist
Toxicology report writer
Tractor operator

Trainer coordinator
Transplant coordinator
Transplant surgeon
Treasury analyst
Treatment team leader

Tumor immunologist
Turfgrass research associate
Tutorial coordinator
TV shopping executive
Type designer

Ultrasound technician
Ultrasound technologist
Underwater archeologist
Utilization review director
Utilization review/discharge planning nurse

Valve engineer
Vice president corporate communications
Vice president technology & product development
Video specialist

Viral immunologist
Vitro virologist
Voice manager
Volcanologist
Waste technician

Water expert
Water pollution specialist
Water quality scientist
Water specialist
Weekend administrator

Wellness consultant
Wildlife biologist
Wildlife ecologist
Word processing operator

Note: In response to questions, it might be well to add a few words on sources used to discover emerging occupations.

These lists were compiled from a wide variety of recent daily, weekly, and monthly newspapers, newsletters and magazines, published by trade and professional associations and publishers. Some represent different names assigned to the same or very similar jobs. Some re-name traditional careers which have been radically changed in nature. Others reflect attempts to name new and different functional, break-downs of areas of responsibility, caused by computerization which has enabled individual workers to handle broader areas. Many are names for wholly new occupations which never existed before. Among these appear many new, very narrow, highly technical specialties.

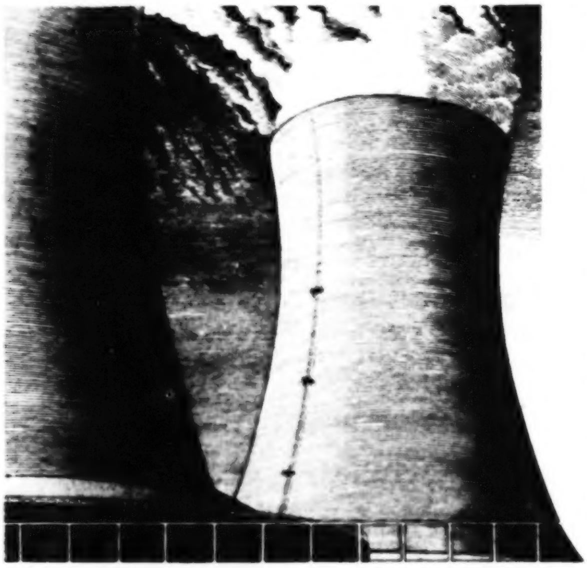
Taken all together these new careers reflect the transition taking place in the work place as we move into the age of information. For some it is unsettling. Others see it as a widening of opportunities, and are exhilarated by the many challenges.

Appendix E
FUTURISTIC EXERCISES

Here are some futuristic exercises designed to be both stimulating and educational.

They are particularly useful with a group of 7 to 10 people. Each group should select a facilitator who helps guide the discussion as well as a recorder who keeps track of what consensus, if any, the group reaches. Suggest to the group that in doing these exercises one's imagination can be expanded. No matter how wild the idea, participants should be willing to discuss it so that others can test these concepts with their own.

The authors have seen this technique work with groups ranging from children in kindergarten to adults with PhD degrees. Excluding selection time, a minimum of an hour is needed to complete even a few exercises. Here are a few examples of topics to stimulate discussion.



1. The U.S. government has just passed a new law to make for greater efficiency. In all legal and social matters, major purchases of homes, automobiles, etc., people will now be required to use their social security number rather than their name. How do you feel about this? What effect will it have on our country?

2. Scientists have discovered how to retard aging of cells in humans. People can now live up to 200 years. How will this affect marriage, careers, and the population explosion? What controls or monitoring are necessary? Would you opt to live to 200 years?

3. The U.S. government has decided that the present distribution of jobs and careers in the U.S. will be changed. All positions now occupied by men will be assigned to women after they have taken a one year education and training program. What will the effect be on men and women?

4. You are a well-known scientist who has discovered, after years of research, how to communicate in depth with dolphins. They are telling you things that will change most people's beliefs all over the world. What do you do?

5. You are a Nobel prize biologist who after years of research finally creates very primitive life in your laboratory. What do you do or not do?

6. Scientists have discovered a new pill with no side effects. If you take it, you will very shortly be brilliant for life. You cannot reverse the process. Will you take the pill?

7. In a future society on earth everyone remains healthy, emotionally and physically, to age 200. Moreover, everyone has an IQ of 200. A few people produce all the food needed. Everyone has all the material possessions he or she wants. What will this society do?

8. Cryologists have now perfected a technique that will allow you to be put to sleep for fifty years and then revived with no change in your physical condition. Will you be willing to try this procedure?

9. The U.S. government has passed a law that everyone has to change his or her career every five years in accordance with each person's abilities, interests, achievements, and personality. How will this affect your life?

10. We can now communicate with all animals. The net effect is that it is now illegal and amoral to eat meat and fish. What changes will take place?

11. You are a married 40-year-old physician in excellent physical shape with in depth knowledge of space. You will be sent to the first moon colony. After five years you are to set up a medical school to train physicians who will take care of the needs of humans in space. What kinds of new specialized educational training will probably be needed? How will you prepare for your own career specialty? You have one year to get ready.

12. An internationally acclaimed chemist discovers how to break down water to perform the same function as gasoline. When, where, and how should she share her discovery?

13. You are assigned the entire responsibility for choosing the first 20 people to colonize a planet similar in climate to earth. You will be the only human inhabitants. None will return for a minimum of ten years. The major criteria is to be the person's career skill plus, of course, excellent health. List the career, age, and sex of the people you will choose and why.

14. The U.S. government has made a law that salaries and total earnings will be reversed. That is the highest level of jobs (such as, a physician, professional atheletes, and corporation presidents) will receive the lowest pay, and lower-level jobs (such as janitor, unskilled laborer, elevator operator, assembly worker, etc) will receive the highest salary. What effect will this have on the world of work? How would it effect you?

15. Thousands of men and women with a much higher IQ than ever tested on earth and much more sophisticated equipment even imagined on earth have landed here. Their mission is obviously peace, but their presence is overwhelming. Most people on earth are accepting any of their requests, including education and training. What would you do as a citizen?

16. You work only five hours a day, two days a week. What is your new lifestyle?

17. Science can produce as many duplicate copies of an individual as we wish to have. What are your reactions?

18. You can have your entire body rebuilt, as needed, of artifcial parts and life prolonged indefinitely. What will you do?

19. You can choose to live in an experimental satellite circling the earth. Will you volunteer?

20. You live in a domed city under the ocean. What are your reactions?

21. You can communicate using mental telepathy. How do you use this new skill?

22. Retirement is required at age 65, but you live to be 175 years old. What is your reaction?

23. The personalities of your friends are constantly changing because of new personality altering drugs. Will you try them out?

24. Marriage "contracts" are now legal for a limited period of time instead of for life. Do you like this new concept? What will the effect be on marriage?

25. Parents now select the sex of their children in advance. How do you feel about it? What will happen?

26. Private automobiles are outlawed except on certain days. What do you think will happen?

27. You can visit other planets just as you visit other cities today. Where will you go, if at all?

28. You live in a raceless society where all men and women are truly equal—even to the clothes they wear and the houses in which they live. What will happen to society?

29. You are not allowed to own land and have to live in an apartment. What are your reactions?

30. Cures are discovered for all diseases. The only cause of death is very old age. How long do you want to live?

31. Mini-computers are installed in each home for the purpose of democratically sampling opinions of the people on national issues. Do you like the idea?

32. A machine has been invented that predicts with absolute accuracy the date of a person's death. Will you use it?

33. Before people can marry, they must submit and pass a computer-administered test on 150 correlates of compatability.

34. Robots take over most of the menial tasks now performed by humans. What will happen to society?

35. People can become invisible. Will you?

36. Man has learned how to bypass human speech and can communicate on higher planes comparable to ESP. Will you communicate in this new mode?

37. Conventional prisons are eliminated in favor of other forms of controlling criminals. (Example: placing electrodes in criminals' brains. If they stray from the territory assigned to them, they experience severe shocks.) Do you think this is a good idea?

38. Electrodes placed within a person's body can serve as identification. The use of credit cards is eliminated. Do you like this method of identification?

39. The great majority of people stop reading and receive their entertainment, news, and other knowledge through media such as television, films, and videotex. What effect will this have on society?

40. A pollution-free electric car is perfected which can reach speeds comparable to those of present cars. It is recharged every 300 miles for half the price of a tank of gasoline. Will you use the new cars?

41. All television sets are programmed to watch you, no matter where you are in your house. Will you own a set?

42. Each female is allowed by law to have only one child during her life-time. Penalties are unusually high. What is the effect on society and you?

43. You are allowed to fill only one small wastebasket with garbage each week or be fined excessively. How will you meet this requirement?

44. You can plug a device into your brain that enables you to feel intense pleasure whenever you like. Will you have it done?

45. You can read other people's minds. What are the positives and negatives?

46. Pills are available that will very quickly give you the skills of any career. Will you take this pill?

47. You can volunteer to join a space colony similar to earth, but the voyage is so long that there will be no return home. Will you volunteer? Yes or no? Why?

48. Average citizens can volunteer to live under the ocean for one year. Living will be simple but comfortable. Pay and benefits are very high, but there will be no return for a year under any circumstances. Will you go?

49. People with a wide variety of skills are being recruited to make it possible for dead planets to be engineered so that they can support life again. Will you volunteer?

50. A pill has been discovered that makes it possible for the recipients never to need sleep. The change is irreversible. Will you take it?

51. A pill is available that allows you to gradually change your sex within a nine-month period. The method is considered absolutely safe by an eminent physician. Would you change your sex?

52. A compressed artificial food is available at very little cost. It will maintain your health, and you never experience hunger pains. Will you try it?

53. There is solid scientific information from eminent scientists all over the world that there is life after death. What effect will this have on society? What effect will this have on you?

54. A computerized mate selection device is available to the general community. So far the use of this machine has dropped the divorce rate from 75% to 5%. Will you use the machine?

55. An inexpensive device can be implanted in your brain. You can turn it on to dream in color on any topic of your choice. Will you get this dream machine? Yes, no, and why?

56. Synthetic cocaine, heroin, LST, and qualudes have been made in the laboratory. They are not habit forming or dangerous, and one can derive the usual pleasure associated with these drugs. Will you try them?

57. Planet Zulu has been scanned and studied for over five years in depth by Voyager 298. The U.S. government has decided to send 150 people to settle this planet. The light years distance are too far for the expedition to return. The planet has all kinds of minerals, plants, trees, oceans, and water available, and the gravity is similar to that of the moon. Make up the age, sex, and careers for this expedition, including any screening devices one would use.

58. The U.S. is tremendously interested in the future of our country—particularly the human talent bank. The government is asking for sperm and ova from men and women all over the United States. Will you participate?

59. A meteor, the size of a planet, is headed towards earth at the rate of 25,000 miles per hour, and scientists so far have not been able to divert it from its course or destroy it. It will hit earth in 90 days. Spaceships are available to go to present space colonies but the total people accepted will be at most 100,000. Will you go on to a colony in space or take your chances and stay on earth? Yes, no, and why?

60. A time machine has been available after billions of dollars of research. One can go back in time or in the future for 1,000 years. Will you choose to go back in time or move years ahead? Which, and why?

61. In the event of a nuclear war, only a few citizens can be saved. What are your priorities for those to be saved? Young and physically fit? Skilled specialists? All scientists? Unskilled health professionals? Doctors, dentists, etc.? Old people? Young people? More women than men? Others?

62. A Swedish pharmacutical concern has developed and satisfactorily tested on humans over a period of two decades, an injection that makes children grow to the extent that they weigh from 350 to 450 pounds with appropriate height and appear to be in better health than men of a smaller stature. Would you be willing to give this injection to your son or daughter?

63. A meteor, the size of a planet, is headed toward earth at the rate of 25,000 miles per hour. Scientists so far have not been able to divert it from its course or destroy it. It will hit earth in 90 days. Spaceships that are available to go to present space colonies can carry at most 100,000 people. Criteria are needed to select them. If chosen, will you go on to a colony in space?

64. Thirty friendly, brilliant people arrive in the U.S. from a planet 26 light years away. They want to take 30 outstanding earth humans of both sexes to visit their planet. Is this a good idea? If accepted, will you go?

65. As punishment for a felony, you are cast on a desert island for life. You can take with you five things that are not human or a pet. What will you take with you?

66. You are to be the first couple to be married on the moon. What kind of ceremony do you both want? Please be as specific as you can in relation to all the events that will take place. How many people will be invited?

67. Is the premise that society should provide satisfactory work and income to all who want to work a valid premise? What would happen if this takes place?

68. It is the year 800,001. Money is no longer to be used as a means of exchange anywhere on Planet Earth. Is this possible? What other ways can people on earth carry out business activities? What are some of the problems? What are some possible solutions?

69. If you were to live your life all over again, what would you do the same and what would you do differently in relation to your job, career and lifestyle?

70. Holland has approved euthanasia. Each person has the right to choose his or her death day rather than linger for a few weeks or longer in agony. Is this a good idea? Do you approve of euthanasia?

71. A pill has been developed that increases a person's IQ by fifty percent. Is this a good idea? Will you take the pill? What are the implications for society?

72. You have the abilities and power to make five major changes in our earth society as it exists today. What will you do? Why?

Appendix F

HIGH TECH FUTURISTIC QUIZ

Answer Each Question—Check True or False or ?

	True	False	?
1. I enjoy science and scientific activities	____	____	____
2. I have a scientific objective	____	____	____
3. I am a task-oriented person	____	____	____
4. I am not particularly interested in working around and with other people	____	____	____
5. I enjoy abstract problems	____	____	____
6. I like to understand physical qualities	____	____	____
7. I prefer to think out problems rather than acting them out	____	____	____
8. I am frequently original and creative	____	____	____
9. I am especially original and creative in scientific areas	____	____	____
10. I am an investigative sort of person	____	____	____
11. I have participated in science fairs	____	____	____
12. I have a science hobby	____	____	____
13. I am future oriented	____	____	____
14. I now belong to a professional association	____	____	____
15. In high school I was part of a scientific group	____	____	____
16. I was a member in college of a science group or club	____	____	____
17. Problem solving is exciting to me	____	____	____
18. I do not like highly structured situations	____	____	____
19. Understanding scientific problems is exciting to me	____	____	____

	True	False	?
20. I have entered a Westinghouse talent search	_____	_____	_____
21. I have won a Westinghouse scholarship award	_____	_____	_____
22. I have a great need to understand the physical world	_____	_____	_____
23. I fuse work and leisure	_____	_____	_____
24. I am not a 9-5 sort of person	_____	_____	_____
25. I have won a science award	_____	_____	_____
26. I am my own person	_____	_____	_____
27. I am more introverted than extroverted	_____	_____	_____
28. I do a lot of professional reading	_____	_____	_____
29. I do well at details	_____	_____	_____
30. I am at ease with figures	_____	_____	_____
31. I am well organized in my work	_____	_____	_____
32. I am comfortable with mathematics	_____	_____	_____
33. I enjoy being in a laboratory setting	_____	_____	_____

Career Score Sheet (Total "Trues")

24-33 ____________________ Full Speed Ahead

18-23 ____________________ Future Promising

12-17 ____________________ Dead Center

6-11 ____________________ Look Into Other Related Careers

0-5 ____________________ Not Your Cup of Tea

Appendix G

INDEX OF EMERGING CAREER FIELDS CITED IN BOOK

Here is a list of those occupations which are cited in the text. The number refers to the chapter in which they were mentioned.

Abstractor 7
Accountant 7
Administrator 6
Aeronautical engineer 11
Aerospace engineer 9

Aerospace scientist 9, 10
Aerospace technician 9

Agent of change 6
Analytical chemist 2
Applications engineer 4
Applications programmer 8
Artificial intelligence psychometrist 4

Astrophysicist 9
Biochemist 2
Biolaser technician 3
Biologist 2
Bioengineer 10

Biomechanical robotics technician 4
Biomedical engineer 10
Biomedical engineering technician 10

Bioprocessing engineer 2
Biotech lawyer 2
Biotechnologist 2
Biotechnical machine operator 2

Business Administrator 7
Cable splicer 6
CAD/CAM designer-engineer 4
CAD/CAM engineer 4

CAD/CAM specialist 8
Celestial mechanics scientist 9
Cellular installer and technician 6

Ceramic engineer 11
Change agent 6

Chemical engineer 2
Chemist 2
Chief information officer 7
Commercial management worker 6
Communications sales 6

Communication specialist 8, 9
Computer detective 8
Computer engineer 5, 8
Computer graphics designer and engineer 8

Computer operator 8, 12
Computer programmer 3, 8
Computer scientist 2, 7
Computer service technician 8
Computer specialist 3

Computer system analyst 8
Corporate information officer 7
Corporate medical counselor 12
Corporate medical director 10
Cytotechnologist 10

Data bank manager 8
Database manager 6, 7
Data communication sales 6
Data/document preparation clerk 7
Data processing 8

Data processing manager 8
Data processing program manager 8
Data processing support worker 8
Data processing specialist 8
Designer 8

Diagnostic medical somographer 10
Documentation specialist 7
Drug research 2
Earth scientist 9
Editor 6, 7

Education and training specialist 7
Educator-trainer 7
Electric therapist 4, 10
Electrical engineer 2, 3, 4, 8, 11
Electricians 3
Electromechanical technician 4

Electro-optic engineer 3
Electro-optic technician 3
Electronic engineer 11
Electronic mail 6
Electronic technician 11

Energy auditor 4
Energy researcher 11
Engineer 2, 3, 6, 7, 11, 12
Engineering designer 11
Engineering technologist 4

Enzymologist 2
Ergonomic expert 8
Ergonomics 6, 8
Ethiests 10
Fermentation technologist 2

Fiber optics 4, 6
Fiber optic technology 6
Filing systems 5
Financial analyst 2
Flying train operator 11

Gene splitting technology 2
Genetic engineer 2, 10
Geologist 8
Geriatrician 10
Gerormtologist 10

Hardware operator 8
Health analyst 10
Health promotion 10
Health physicist 3
High energy physicist 11

Hydromechanical technician 4
Image management 7
Immunologist 2
Implementation specialist 7
Indexer 7

Industrial designer 6
Industrial engineer 4, 8, 9
Industrial microbiologist 2
Industrial robotic psychologist 4
Information broker 6, 7
Information careers 5, 7

Information management 5, 7
Information processor 8
Information resource manager 7
Information science 6
Information services and systems operator 7

Information specialist 6
Information studies teacher 7
Information systems designer 7
Information systems engineer 7
Information technologist 5

Installation technician 4
Installer 3
Instrumenation specialist 2
Internal communications network engineer 7

International marketing 6
Inospheric plasma physicist 9
Knowledge engineer/expert systems programmer 8
Labor relations worker 6

Lab robot technologist 4
Laser electro-optical technician 3
Laser/electro optics engineer 3
Laser nurse specialist 3
Laser optic technician 3

Laser technologist 3
Lawyer 2
Librarian 7, 8
Library science worker 7
Line installer 6

Magnetic resonance imaging technologist 10
Manager 2, 6
Manager information services and systems 7

Manufacturing and laser equipment salesperson 3
Manufacturing engineer 4
Marketing personnel 7
Marketing and sales personnel 7

Marketing director 7
Mechanical engineer 4
Medical administration 10
Medical computing technologist 8
Medical imaging technician 11

Medical technologist 11
Microbiologist 2
Microfilm laboratory supervisor 7
Micrographics technician 5
Micrographics/phoduplication department supervisor 7

Micrographics supervisor 7
Micro gravity scientist 9
Monoclonal antibody technologist 2
Moon base director of manufacturing 9
Network analyst 6

Nursing home physician 10
Ocean mining engineer 12
Office networking technologist 8
Office networking consultant 6
On-line search specialist 7

Operator 3
Opthalmogogist 3
Optical and laser discs 5
Optical conputer technician 3
Optical data preparation clerk 7

Optical data preparation specialist 7
Optical engineer 6
Optical inspector 3
Orthotics worker 4
Paleobiologist ?

Paralegal worker 6
Patent lawyer 2
Personnel specialist 2
Pharmaceutical medicine technologist 2
Physician 3, 8

Physician executive 10
Physicist 3, 11
Planetary camera operator 7
Planetary geologist 9
Planetary scientist 9

Planner 7
Policy maker 10
Position emission tomography consultant 9, 10
Preservation office manager 7

Primary care physician 10
Process control personnel 2
Product engineer 4
Professional manager 2
Programmer 3

Quality assurance technician 7
Radio astronaut 9
Radiology technician 10
Real estate broker 9
Records manager 7

Regulatory specialist 2
Registered nurse 10
Repairer 3
Repairer interactive computer system 8
Research and development worker 3, 11

Research worker 7
Robot attendant 4
Robot consultant 4
Robot manufacturer 4
Robot operator 4

Robot psychologist 4
Robot research center worker 4
Robotic application engineer 4
Robotic mechanic 4
Robotic repair worker 4

Robotic service technician 4
Robotics industrial hygiene technician 4
Robotics quality assurance inspector 4
Robotics worker 3
Rotary camera operator 7

Safety engineer 3
Sales and marketing 6
Sales engineer 3
Sales representive 3, 7
Scientific programmer 8
Selenologist 9

Shuttle flight attendant 6
Social psychologist 6
Software engineer 7
Space habitat builder 9
Space historian 10

Space hotel restaurant manager 9
Space insurance broker 9
Space mining engineer 9
Space pharmacist 10
Space physician 10

Space police 9, 10
Space psychiatrist 9
Space real estate broker 10
Space scientist 9
Space security personnel 9, 10

Space systems analyst 8
Space teacher 10
Space travel agent 9
Space university director 9
Space vehicle designer 9

Surgical technician 10
Switching technician 6
Systems analyst 3, 6
Systems engineer 7
System integration specialist 7

Teacher 7
Technology specialist 8
Tele and cable shopping installer 6
Telecommunications lawyer 6
Telecommunications manager and vice president 6

Telecommunications 6
Telecommunications consultant 6
Telecommunications information officer 6
Telephone equipment repairer 6

Ultrasound machine technician 10
Vice-president, information center 7
Videotext 5
Work flow analyst 7
Writer 6, 7